United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Minnesota Agricultural
Experiment Station

Soil Survey of Wadena County, Minnesota

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How To Use This Soil Survey

General Soil Map

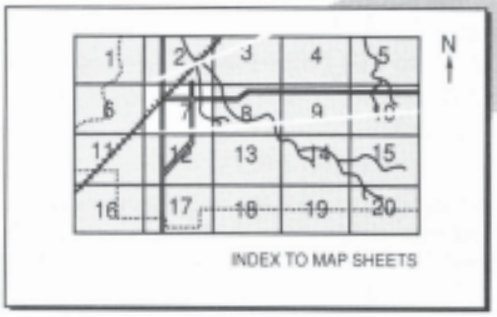
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

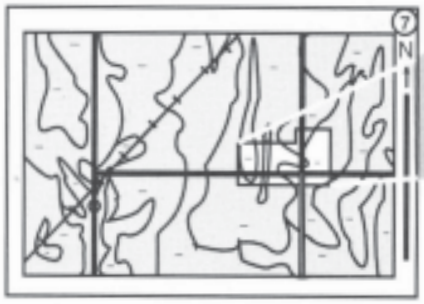
To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



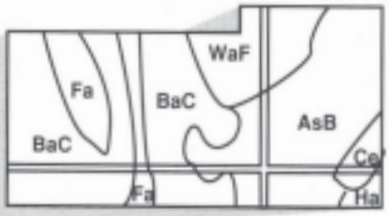
INDEX TO MAP SHEETS

MAP SHEET

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET



AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1986. Soil names and descriptions were approved in 1987. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1986. This survey was made cooperatively by the Soil Conservation Service and the Minnesota Agricultural Experiment Station. Assistance also was provided by the Agricultural Extension Service, the Minnesota Department of Natural Resources, and the Soil and Water Conservation Board. The survey was funded partially by the Legislative Commission for Minnesota Resources and by Wadena County. It is part of the technical assistance furnished to the Wadena Soil and Water Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: An area of the Menahga-Friendship-Seelyeville association. Woodland is the dominant land use. The areas of wetland have been developed as the Huntersville Water Impoundments, a Wesmin Resource Conservation and Development area project.

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Issued September 1991

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Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Wadena County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

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Soil Survey of Wadena County, Minnesota

By David L. Aldeen, Soil Conservation Service

Fieldwork by Ward J. Aas and David L. Aldeen, Soil Conservation Service, and Timothy Cain and Kermit Larson, Minnesota Agricultural Experiment Station

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
Minnesota Agricultural Experiment Station

WADENA COUNTY is in the central part of Minnesota (fig. 1). It has a total land area of about 536 square miles, or 343,550 acres. Wadena, the county seat, is in the extreme southwest corner of the county.

The agricultural enterprises in the county are mainly dairy farming, livestock and hog operations, and production of grain for feed *(11)*. Forest management is also an important enterprise. Pulpwood, saw logs, and Christmas trees are the main products. The Crow Wing Canoe, Saddle, and Snowmobile Trails are important recreational areas in the county.

This survey updates the soil survey of Wadena County published in 1926 *(7)*. It provides additional information and larger maps, which show the soils in greater detail.

Soil scientists were denied access to a few tracts in the county. These areas were mapped using knowledge of the surrounding areas, older soil maps, and aerial photographs. The descriptions of soils on these tracts may be less accurate than those of soils in areas where soil scientists had access to the land and could carefully examine the soils.

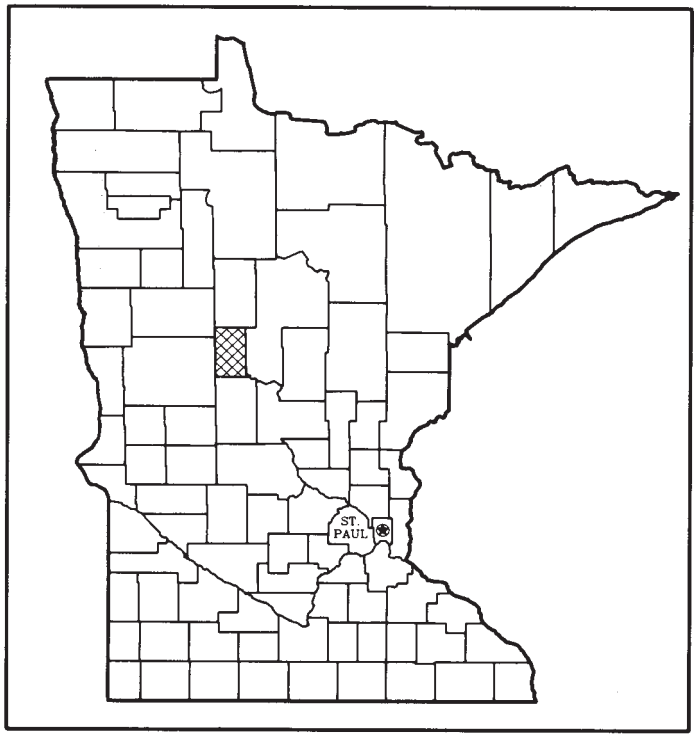

Figure 1.—Location of Wadena County in Minnesota.

General Nature of the County

This section gives general information about Wadena County. It describes settlement and history, relief and drainage, ground water, farming, forestry, transportation facilities, climate, and geological history and geomorphology.

Settlement and History

Indians used Wadena County as hunting grounds. French and British fur traders were the first white men

to venture into the area. Trading posts were established along the Leaf River in Wing River Township, where the Leaf River enters the Crow Wing River, and at the confluence of the Partridge and Crow Wing Rivers. In 1844 a land route was constructed through Wadena County. This route followed the Leaf River and was called the Red River Ox Cart Trail *(6)*.

Wadena County was included in the Indian land concession of 1855. In June 1858, the state legislature established Wadena County and named the town of Wadena as temporary county seat. At that time Wadena was located along the western side of the Crow Wing River, between the Leaf and Partridge Rivers. When the railroad was constructed a few miles to the south of this site, Wadena was moved to its present location. In February 1873, Wadena County was organized and Wadena officially became the county seat *(7)*.

After the construction of the railroad in 1873, the county became attractive to homesteaders. The northern part of the county was settled dominantly by the Finnish, the east-central part by Germans, and the southern part by the Danish, Norwegian, Swedish, and English. Agriculture and forestry were the major industries. Most towns were built along the railroad line. In 1930, about two-thirds of the people lived in rural areas, but by 1960 the number declined to about 40 percent. The population of the county was 10,699 in 1920 and 14,174 in 1980.

Wadena County consists of 15 townships. The southern six townships were organized in the early 1880's. As the population of the county increased, other areas were organized into townships, and by 1898 the entire county was organized. The incorporated cities in the county are Aldrich, Menahga, Nimrod, Sebeka, Verndale, and Wadena. The unincorporated areas are Bluegrass, Huntersville, and Oylen.

Relief and Drainage

The county is divided into two distinct areas—the Wadena drumlin field and the outwash plains. The drumlin field is dominantly in the west-central part of the county. A few small areas are in the eastern and southern parts. The drumlins are nearly level to sloping. Slopes are smooth and are short to moderately long. Local relief varies from a few feet between the drumlins to 30 to 80 feet adjacent to the outwash plains. The drumlin field makes up about 30 percent of the county.

The sandy outwash areas are dominantly nearly level to gently sloping, except where they are adjacent to rivers and lakes. Slopes are smooth and are short to long. Local relief generally is less than 10 feet, but it ranges to as much as 40 feet. Closed depressions are common in the outwash areas. The outwash plains make up about 70 percent of the county. They extend north into Hubbard County, southwest into Ottertail County, and south into Todd County.

In the northwestern part of the county, west of Menahga, the drumlin field has an elevation of about 1,510 feet, which is the highest area in the county. The lowest area, which is about 1,225 feet, is along the Crow Wing River, in the southeast corner of the county. The mean elevation for the county is about 1,350 feet.

Drainage is slow in most of the depressions. Runoff from these areas also is slow, and the water ponds frequently. Drainage systems may be needed to remove the excess water. A ditch system was constructed years ago, but many of the main and lateral ditches have not been maintained.

All runoff in the county flows into the Crow Wing River and its tributaries. The major tributaries are the Cat, Leaf, Partridge, Red Eye, Shell, and Wing Rivers. Watersheds in the county contain many small creeks, and in many places the creeks flow through a series of depressions rather than through a carved valley.

Ground Water

Most ground water in the county is in pores or openings between particles of sand and gravel in glacial outwash or glacial till. Thickness of the saturated area is as much as 70 feet, but it averages about 36 feet. Some areas do not have a saturated zone. The ground water is shallow in the outwash areas because the thick layers of glacial till restrict the downward movement of water. In areas that have glacial till above and below outwash sand and gravel, well water is available in lenses of sand and gravel within the glacial till *(12)*.

The quality of the water is affected by environmental factors. Levels of nitrates are highly variable in the outwash areas. High concentrations of nitrates generally are the result of human or animal activity. Pollution of shallow aquifers by nitrates commonly is caused by barnyard waste, effluent from septic tanks, or agricultural fertilizer. If water is to be used for domestic purposes, care should be taken to prevent nitrate contamination.

Farming

Farming in the county increased with the construction of the first railroad in the 1870's. During the 1920's, dairy farming was dominant and corn and oats were the most commonly grown crops *(6)*. Dairy farming is still the main farm industry, but beef, swine, poultry, and sheep operations are also important. Most crops are grown as feed for livestock, and little is shipped out of the county. Corn, small cereal grain, and alfalfa hay are

the main crops, but some sunflowers, edible beans, and soybeans and a variety of specialty crops, such as cucumbers, potatoes, and bluegrass sod, also are grown.

Irrigation systems were introduced into the county in about 1963. In 1974, 38 farms were irrigating a total of about 1,800 acres. In 1978, after the dry period in the mid-1970's, the number of farms using irrigation increased to 78 and a total of about 7,780 acres was irrigated. The number of irrigated farms and acres has remained fairly constant since that time.

In 1982, there were about 855 farms in the county and they averaged about 256 acres in size. About 129,400 acres was used as cropland. In 1984, about 55,500 acres was planted to hay, 51,300 acres to corn and corn silage, 19,400 acres to small grain, 1,100 acres to edible beans, and 2,100 acres to soybeans.

Forestry

About 113,700 acres in the county is forest land. About 107,300 acres is commercial timber land, of which about 84 percent is privately owned. Farmers are the largest private landowners, with a total of about 51,500 acres. About 16 percent of the commercial forest land is publicly administered, of which about 17,200 acres is administered by the State of Minnesota *(10)*.

Softwood forest types cover about 44,400 acres, or 41 percent, of the commercial forest land. There are about 36,600 acres of jack pine and 3,500 acres of red pine. Hardwood forest types cover about 59 percent of the commercial forest land. Aspen, which is the dominant forest type, grows on about 41,700 acres, or 39 percent, of the commercial forest land. About 14,100 acres supports oak. Other forest types in the county are black spruce, balsam fir, tamarack, balsam poplar, elm-ash-cottonwood, and maple-basswood.

White pine was once the dominant sawtimber species in the county *(18)*. In 1976, 51 percent of the timber harvested was jack pine. About 57 percent of the commercial forest land supports pole-size timber stands. Diseases and insects have attacked some stands. Jack pine budworm has infected quite a few trees, and red rot has infected some trees. Some stands of aspen in the county are affected by hypoxylon canker, black rot, and fomes ignarius *(14)*.

Many private sawmills are in the county. Markets for pulp, poles, and saw logs are in Brainerd, Cloquet, Park Rapids, Sartell, Bemidji, and Cass Lake. Wood shaving plants in adjoining counties create a demand for aspen, basswood, and other hardwoods and for pine. Christmas tree plantations also contribute to the forest industry in the county.

Transportation Facilities

The Burlington Northern Railroad runs from the southeastern part of the county through the city of Wadena en route to the West Coast.

About 60 miles of state and federal highways cross the southern and western parts of the county. There are also about 844 miles of county and township roads. Airports are located in Wadena and Staples. A bus line and several truck lines also serve the county.

Climate

Prepared by the National Climatic Data Center, Asheville, North Carolina.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Wadena in the period 1951 to 1981. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 10 degrees F and the average daily minimum temperature is -2 degrees. The lowest temperature on record, which occurred at Wadena on January 16, 1972, is -41 degrees. In summer, the average temperature is 67 degrees and the average daily maximum temperature is 79 degrees. The highest recorded temperature, which occurred at Wadena on August 19, 1976, is 102 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 26.5 inches. Of this, 20 inches, or about 75 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 15 inches. The heaviest 1-day rainfall during the period of record was 5.25 inches at Wadena on August 16, 1955. Thunderstorms occur on about 33 days each year.

The average seasonal snowfall is 48 inches. The greatest snow depth at any one time during the period of record was 36 inches. On the average, 72 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines

65 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the north. Average windspeed is highest, 14 miles per hour, in spring.

Geologic History and Geomorphology

Continental glaciation during the Pleistocene epoch was important in the formation of the present landscapes in Wadena County. Because of the thick glacial deposits, limited information is available about the geology of the bedrock in the county *(13)*. Most of the information concerning the type of bedrock and the depth to bedrock has been determined from well drilling logs. In section 11 of the Leaf River Township, "blue soapstone" was found at a depth of about 250 feet, which suggests the presence of blue Cretaceous shale. Near Aldrich, slate was found at a depth of about 100 feet. Thickness of the glacial till is unknown, but based on limited data from well digging operations, it generally is thought to be at least 250 to 300 feet *(8)*.

Wadena County consists of two geomorphic areas—the Wadena drumlin field and the Park Rapids-Staples outwash plain. The Wadena drumlin field formed during the early to middle part of the Wisconsin Glaciation. Radiocarbon dating of wood samples from beneath the glacial till suggests that the drumlins are about 30,000 to 60,000 years old.

The Wadena drumlin field covers nearly all of Wadena County and most of Todd County, and it extends into parts of the adjacent Becker, Cass, Hubbard, and Ottertail Counties. Parts of the drumlin field have been truncated and buried by outwash and glacial till from the slightly younger St. Croix moraine to the east, the Itasca moraine to the north, and the Alexandria morainic complex to the west and south. There are about 1,200 visible drumlins in the drumlin field. A recent study, however, suggests that there are actually nearly 2,000 drumlins, but some of them are completely or partially buried by younger deposits *(20)*.

The fanlike shape of the drumlin field suggests that ice moved from the northeast. There are two main theories regarding the formation of drumlins. Studies of pebble lithology and carbonate content suggest that glacial till moved southeastward from the limestone area of the Winnipeg lowlands into northern Minnesota. This movement was then diverted by another glacial lobe advancing from the east. A more recent study, however, suggests that older till from a northwestern source was in place before the drumlins. The present drumlins resulted from a progressive mixing of glacial till from a northeastern source; ice lobes and flows molded the drumlins.

About 20,500 years ago, the Rainy and Superior glacial lobes advanced to the St. Croix moraine. At about the same time, the Wadena lobe advanced to the Itasca moraine. The meltwater generated at these ice margins flowed southward and created the Park Rapids outwash plain and the Long Prairie River Valley. Outwash covered large portions of the drumlin field, especially in the northern and eastern parts. Stagnant masses of ice filled the depressions, thus allowing a continuous blanket of sand to form over the landscape. This blanket of sand protected and insulated the ice blocks. The ice blocks probably melted about 12,000 years ago and formed the pitted outwash plain and numerous lakes, such as Blueberry, Crow Wing, Jim Cook, Yeager, and Finn Lakes *(15)*.

About 16,000 years ago, the Des Moines glacial lobe advanced eastward. Large amounts of outwash along an ice front between Detroit Lakes and Henning were carried by meltwater down the Leaf River Valley. The Redeye River was also an outlet for this outwash. Outwash was deposited northward in the Long Prairie River Valley, which eventually reversed the flow of the river. Two terraces formed along the Leaf River Valley. The outwash on the upper-level terrace was thick enough to fill interdrumlin swales. This terrace is about 1 mile south of the Leaf River, and it extends into Todd and Ottertail Counties. The lower-level terrace is adjacent to the Leaf River channel. All of the Des Moines lobe meltwater eventually moved eastward through the Pillager gap and then southward, and it contributed to the development of the Mississippi River system.

After a period of higher temperatures and droughtiness, which ended about 7,000 years ago, the climate became cooler and moister. It was during this period that peat began to develop in the poorly drained and very poorly drained lowlands and interdrumlin swales. This peat is more than 17 feet thick in some places.

In the mid-1800's, land was cleared for agricultural use or for logging. As a result, the rates of soil erosion and gullying were accelerated, which also influenced the topography of the drumlin field and outwash plains.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the

kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar)

inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Some soil boundaries and soil names do not match those of adjoining areas that were surveyed earlier. The differences are a result of changes and refinements in series concepts, the use of different slope groupings, and application of the latest soil classification system.

Soil Descriptions

1. Menahga-Friendship-Seelyeville Association

Nearly level to very steep, excessively drained, moderately well drained, and very poorly drained, sandy or organic soils on uplands

Setting

Landscape position: Shallow depressions, rises, and escarpments
Landform: Uplands
Slope: 0 to 45 percent

Composition

Percentage of survey area: 18
Percentage of major soils: Menahga—57; Friendship—12; Seelyeville—10
Percentage of minor soils: 21

Soil Properties and Qualities

Menahga

Drainage: Excessively drained
Parent material: Glacial outwash
Surface texture: Loamy sand

Friendship

Drainage: Moderately well drained
Parent material: Outwash material
Surface texture: Loamy sand

Seelyeville

Drainage: Very poorly drained
Parent material: Highly decomposed herbaceous plant material
Surface texture: Muck

Minor Soils

- The very poorly drained Leafriver and Rifle soils in shallow depressions
- The poorly drained Roscommon soils along the outer edges of depressions
- The somewhat poorly drained Meehan soils in concave areas

Use and Management

Primary use: Woodland
Secondary uses: Pasture, hayland
Major management factors: Menahga—water erosion, droughtiness, soil blowing; Friendship—droughtiness, soil blowing; Seelyeville—wetness

2. Markey-Meehan-Roscommon Association

Nearly level and gently sloping, very poorly drained to somewhat poorly drained, sandy and organic soils on uplands

Setting

Landscape position: Broad flats, shallow depressions, and slight rises
Landform: Uplands
Slope: 0 to 3 percent

Composition

Percentage of survey area: 28
Percentage of major soils: Markey—23; Meehan—22; Roscommon—20
Percentage of minor soils: 35

Soil Properties and Qualities

Markey

Drainage: Very poorly drained
Parent material: Highly decomposed herbaceous plant material over mineral material
Surface texture: Muck

Meehan

Drainage: Somewhat poorly drained
Parent material: Glacial outwash
Surface texture: Loamy sand

Roscommon

Drainage: Poorly drained
Parent material: Glacial outwash
Surface texture: Loamy sand

Minor Soils

• The very poorly drained Cathro, Leafriver, and Rifle soils in depressions and on broad flats
• The moderately well drained Friendship soils in the slightly higher areas
• The moderately well drained Huntersville and well drained Redeye soils, which formed in sandy material over loamy glacial till and are in concave or convex areas

Use and Management

Primary use: Woodland
Secondary uses: Pasture, hayland, cropland
Major management factors: Markey—wetness; Meehan—droughtiness, soil blowing; Roscommon—soil blowing, wetness

3. Verndale-Nymore-Forada Association

Nearly level to sloping, very poorly drained, poorly drained, well drained, and excessively drained, loamy and sandy soils on uplands

Setting

Landscape position: Plane, concave, and convex areas
Landform: Uplands
Slope: 0 to 12 percent

Composition

Percentage of survey area: 22
Percentage of major soils: Verndale—36; Nymore—26; Forada—15 (fig. 2)
Percentage of minor soils: 23

Soil Properties and Qualities

Verndale

Drainage: Well drained
Parent material: Loamy mantle over glacial outwash
Surface texture: Sandy loam

Nymore

Drainage: Excessively drained
Parent material: Glacial outwash
Surface texture: Loamy sand

Forada

Drainage: Poorly drained and very poorly drained
Parent material: Loamy sediment over outwash
Surface texture: Loam

Minor Soils

• The very poorly drained Cathro, Leafriver, Markey, and Seelyeville soils near the center of medium and large depressions
• The well drained Dorset soils in landscape positions similar to those of the Verndale soils
• The moderately well drained Duelm and Oylen soils in the slightly lower areas
• The well drained Rockwood soils in the more sloping areas

Use and Management

Primary use: Cropland
Secondary uses: Woodland, pasture, unmanaged land
Major management factors: Verndale—droughtiness; Nymore—droughtiness, soil blowing; Forada—wetness

4. Markey-Isan-Duelm Association

Nearly level, very poorly drained, poorly drained, and moderately well drained, organic and sandy soils on uplands

Setting

Landscape position: Plane and slightly concave areas on broad flats, low rises, and bogs
Landform: Uplands
Slope: 0 to 2 percent

Composition

Percentage of survey area: 2
Percentage of major soils: Markey—32; Isan—27; Duelm—19
Percentage of minor soils: 22

Soil Properties and Qualities

Markey

Drainage: Very poorly drained

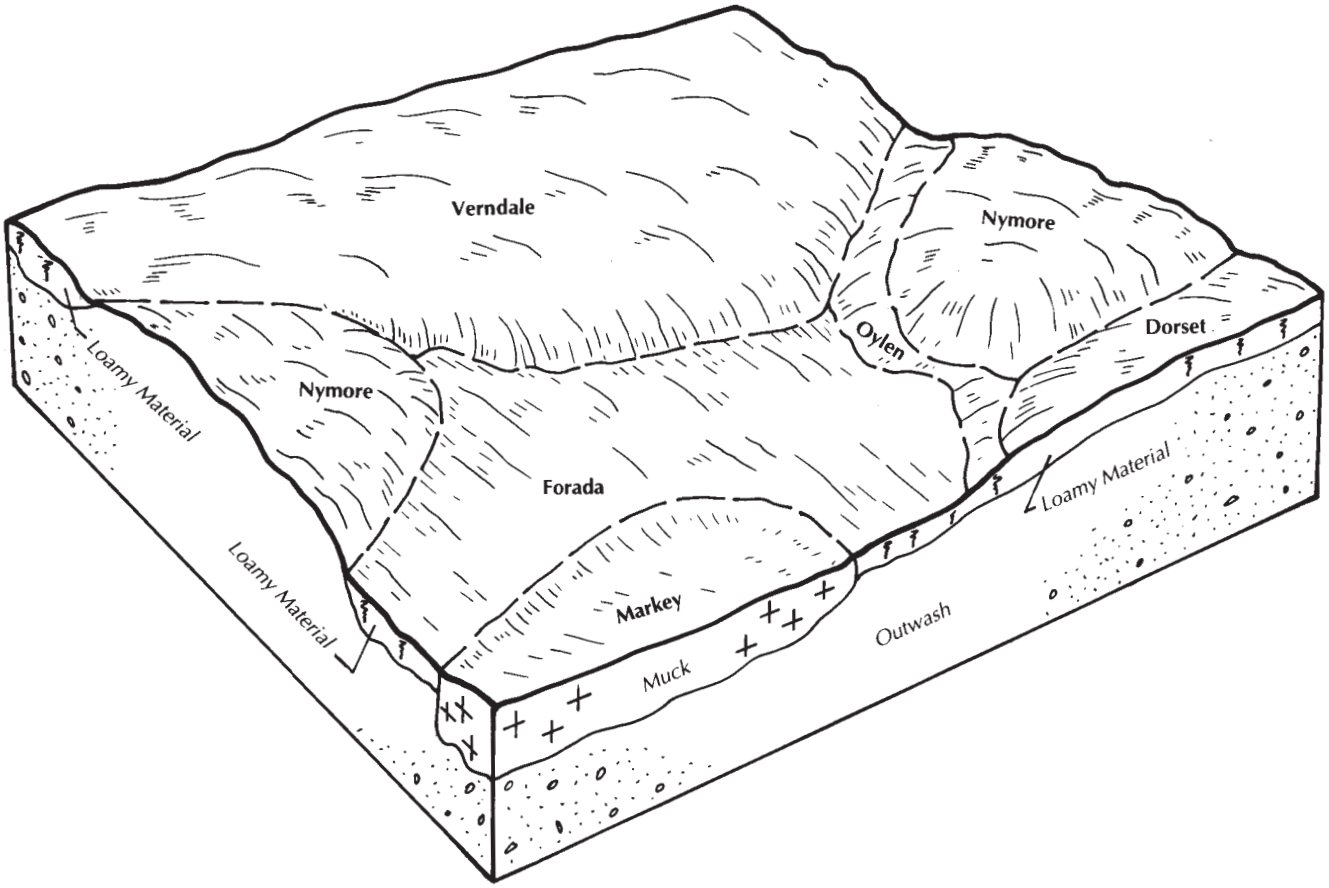

Figure 2.—Typical pattern of soils and parent material in the Verndale-Nymore-Forada association.

Parent material: Highly decomposed herbaceous plant material over mineral material
Surface texture: Muck

Isan

Drainage: Poorly drained
Parent material: Glacial outwash
Surface texture: Loamy sand

Duelm

Drainage: Moderately well drained
Parent material: Glacial outwash
Surface texture: Loamy sand

Minor Soils

- The very poorly drained and poorly drained Forada soils in landscape positions similar to those of the Isan soils
- The poorly drained and very poorly drained Evart and poorly drained Fordum soils on flood plains
- The very poorly drained Leafriver and Seelyeville soils in depressions
- The excessively drained Nymore soils in the higher areas

Use and Management

Primary use: Cropland
Secondary use: Wildlife habitat
Major management factors: Markey—wetness; Isan—wetness, soil blowing; Duelm—droughtiness

5. Blowers-Paddock-Runeberg Association

Nearly level and gently sloping, moderately well drained, somewhat poorly drained, and very poorly drained, loamy soils on uplands

Setting

Landscape position: Slightly concave, convex, and plane areas
Landform: Uplands
Slope: 0 to 5 percent

Composition

Percentage of survey area: 21

Percentage of major soils: Blowers—39; Paddock—22; Runeberg—10
Percentage of minor soils: 29

Soil Properties and Qualities

Blowers

Drainage: Moderately well drained
Parent material: Glacial till
Surface texture: Sandy loam

Paddock

Drainage: Somewhat poorly drained
Parent material: Glacial till
Surface texture: Loam

Runeberg

Drainage: Very poorly drained
Parent material: Colluvium over glacial till
Surface texture: Mucky loam

Minor Soils

• The very poorly drained Cathro, Haug, Leafriver, Markey, Rifle, and Seelyeville soils in landscape positions similar to those of the Runeberg soils
• The moderately well drained Huntersville and well drained Redeye soils in the higher areas
• The well drained Rockwood soils in the convex, more sloping areas

Use and Management

Primary use: Cropland
Secondary uses: Pasture, hayland, wildlife habitat
Major management factors: Blowers—water erosion; Paddock—wetness, stones; Runeberg—wetness

6. Friendship-Menahga-Huntersville Association

Nearly level to moderately steep, moderately well drained and excessively drained, sandy soils on uplands

Setting

Landscape position: Plane, slightly concave, and convex areas on rises
Landform: Uplands
Slope: 0 to 15 percent

Composition

Percentage of survey area: 6
Percentage of major soils: Friendship—32; Menahga—27; Huntersville—20 (fig. 3)
Percentage of minor soils: 21

Soil Properties and Qualities

Friendship

Drainage: Moderately well drained
Parent material: Outwash material and glacial till
Surface texture: Loamy sand

Menahga

Drainage: Excessively drained
Parent material: Glacial outwash
Surface texture: Loamy sand

Huntersville

Drainage: Moderately well drained
Parent material: Glacial outwash and dense till
Surface texture: Loamy fine sand

Minor Soils

• The moderately well drained Blowers soils in landscape positions similar to those of the Huntersville soils
• The somewhat poorly drained Meehan soils in the slightly lower areas
• The poorly drained Roscommon soils in plane or concave areas
• The well drained Redeye soils in convex areas
• The very poorly drained Seelyeville soils near the center of deep depressions
• The poorly drained Staples soils on foot slopes or in slight depressions

Use and Management

Primary uses: Woodland, unmanaged land
Secondary uses: Hayland, wildlife habitat
Major management factors: Soil blowing, low available water capacity

7. Evart-Menahga-Fordum Association

Nearly level to very steep, very poorly drained, poorly drained, and excessively drained, loamy and sandy soils on flood plains and uplands

Setting

Landscape position: Plane and concave areas, adjacent escarpments
Landforms: Flood plains, uplands
Slope: 0 to 45 percent

Composition

Percentage of survey area: 3
Percentage of major soils: Evart—31; Menahga—22; Fordum—12
Percentage of minor soils: 35

Soil Properties and Qualities

Evart

Drainage: Poorly drained and very poorly drained
Parent material: Alluvium
Surface texture: Loam

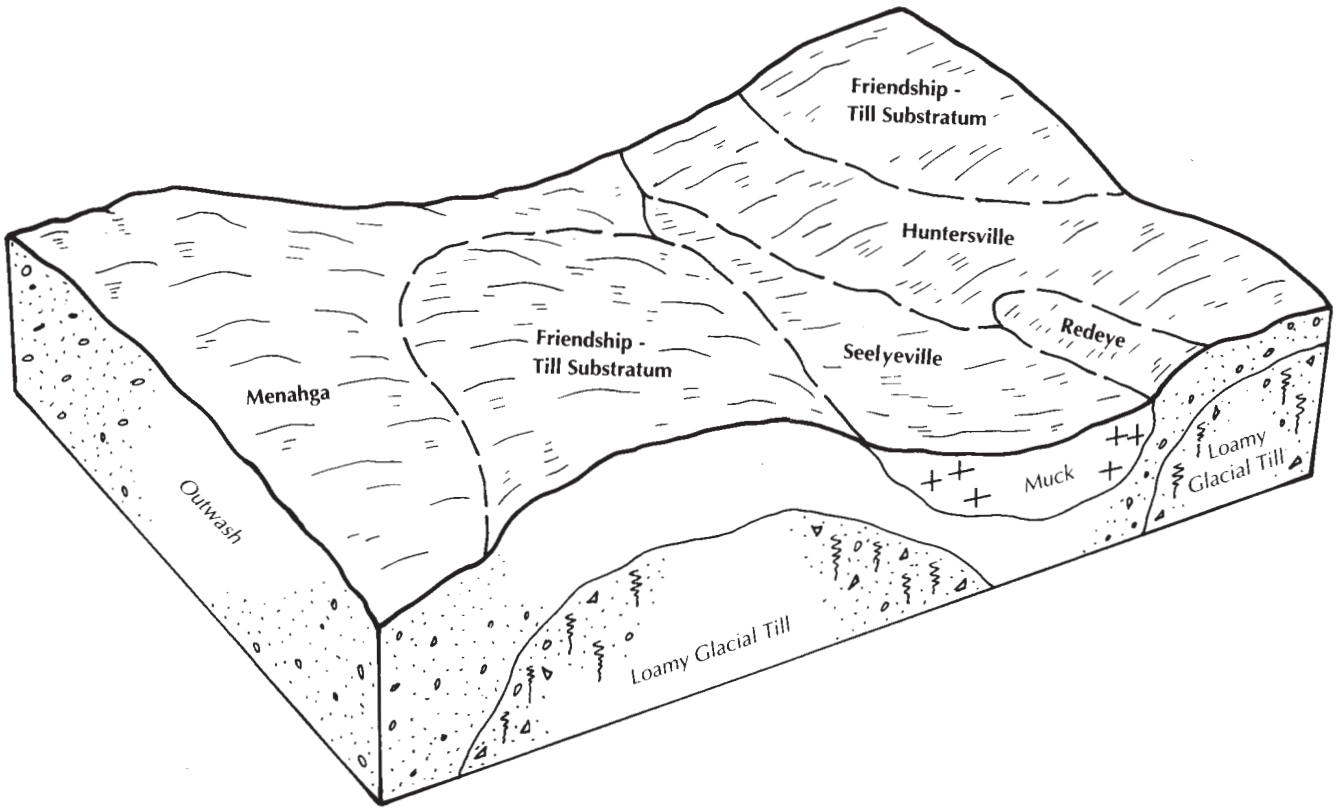

Figure 3.—Typical pattern of soils and parent material in the Friendship-Menahga-Huntersville association.

Menahga

Drainage: Excessively drained
Parent material: Glacial outwash
Surface texture: Loamy sand

Fordum

Drainage: Poorly drained
Parent material: Alluvium
Surface texture: Silt loam

Minor Soils

- The moderately well drained Friendship and somewhat poorly drained Meehan soils in the slightly higher areas adjacent to the flood plains
- The very poorly drained Seelyeville soils in depressions

Use and Management

Primary uses: Woodland, unmanaged land
Secondary uses: Hayland, wildlife habitat
Major management factors: Evart and Fordum—wetness, flooding; Menahga—water erosion, droughtiness, soil blowing

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Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Rockwood sandy loam, 2 to 6 percent slopes, is a phase of the Rockwood series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Evart-Isan complex, channeled, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Riverwash is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

As a result of changes in soil series concepts and differences in soil patterns and map unit design, some soil boundaries and names in this survey do not match those in adjacent counties.

This publication includes suggested management practices that are intended to increase crop production and to help reduce soil blowing, water erosion, and wetness. Over a period of time, some or all of these practices may or may not be in accordance with federal, state, and local laws and with agency rules and guidelines.

Soil Descriptions

82B—Redeye loamy sand, 1 to 6 percent slopes

Composition

Redeye soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and convex areas
Landform: Drumlins
Shape of areas: Elongated
Size of areas: 5 to 75 acres

Typical Profile

0 to 3 inches—very dark gray loamy sand
3 to 18 inches—brown sand
18 to 26 inches—yellowish brown loamy sand
26 to 38 inches—yellowish brown sandy loam
38 to 52 inches—dark yellowish brown sandy loam
52 to 60 inches—light yellowish brown, calcareous sandy loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Rapid in the upper part; moderately slow to very slow in the lower part
Available water capacity: Low
Organic matter content: Moderately low or moderate
Surface runoff: Slow
Depth to the water table: More than 6 feet
Other characteristics: Root-restricting layer at a depth of 52 inches

Inclusions

Contrasting inclusions:
• Very poorly drained soils in strongly concave areas and in the lower areas
• The somewhat poorly drained Meehan soils in nearly level areas and in the lower areas
• The somewhat poorly drained Paddock soils in nearly level areas and in the lower areas
• The poorly drained Roscommon soils in the lower areas
• The poorly drained Staples soils in the lower areas and in slightly concave areas
Similar inclusions:
• Soils that have many cobbles and stones on the surface
• Soils that are moderately well drained
• Soils that are sandy to a depth of more than 40 inches or less than 20 inches
• Soils that have a surface layer of sand, fine sand, or loamy fine sand

Use and Management

Cropland:
• Irrigation may be needed to overcome droughtiness if costly specialty crops are grown.
• Using conservation tillage systems that keep crop residue on the surface and growing cover crops conserve moisture and help to control soil blowing and water erosion.
Pasture and forage:
• Drought-resistant species, such as alfalfa, bromegrass, big bluestem, and indiangrass, are best suited.
• Overgrazing increases the runoff rate and reduces the quality of pastures.
• Proper stocking rates, deferment of grazing during dry periods, applications of fertilizer, weed control, and rotation grazing in summer help to keep the pastures in good condition.
• Pastures that are in good condition can make more efficient use of rainfall, which reduces the hazards of water erosion and soil blowing.
Woodland:
• Adequate site preparation and control of competing vegetation are needed for successful establishment of planted seedlings.
• Regeneration is most successful if trees are harvested in winter.
• Disturbance of the surface layer can limit regeneration of aspen by reducing the fertility of the soil and damaging the parent roots of trees.
• Loose sand interferes with the traction of wheeled equipment.

Interpretive Groups

Land capability classification: IIIs
Woodland ordination symbol: 6S

82C—Redeye loamy sand, 6 to 12 percent slopes

Composition

Redeye soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Convex areas
Landform: Drumlins
Shape of areas: Elongated
Size of areas: 4 to 60 acres

Typical Profile

0 to 4 inches—very dark grayish brown loamy sand
4 to 7 inches—dark brown sand
7 to 31 inches—yellowish brown and brown sand
31 to 48 inches—dark yellowish brown and brown sandy loam and loamy sand
48 to 60 inches—yellowish brown, calcareous sandy loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Rapid in the upper part; moderately slow to very slow in the lower part
Available water capacity: Low

Organic matter content: Moderately low or moderate
Surface runoff: Medium
Depth to the water table: More than 6 feet
Other characteristics: Root-restricting layer at a depth of 48 inches

Inclusions

Contrasting inclusions:
• The somewhat poorly drained Meehan soils in nearly level areas and in the lower areas
• The somewhat poorly drained Paddock soils in nearly level areas and in the lower areas
• Poorly drained soils in the lower areas
Similar inclusions:
• Soils that have more gravel, cobbles, or stones in the upper part of the subsoil
• Soils that are moderately well drained
• Soils that are sandy to a depth of more than 40 inches or less than 20 inches
• Soils that have a surface layer of sand, fine sand, or loamy fine sand

Use and Management

Cropland:
• Irrigation may be needed to overcome droughtiness if costly specialty crops are grown.
• Using conservation tillage systems that keep crop residue on the surface and growing cover crops conserve moisture and help to control soil blowing and water erosion.
Pasture and forage:
• Drought-resistant species, such as alfalfa, bromegrass, big bluestem, and indiangrass, are best suited.
• Overgrazing increases the runoff rate and reduces the quality of pastures.
• Proper stocking rates, deferment of grazing during dry periods, applications of fertilizer, weed control, and rotation grazing in summer help to keep the pastures in good condition.
• Pastures that are in good condition can make more efficient use of rainfall, which reduces the hazards of water erosion and soil blowing.
Woodland:
• Adequate site preparation and control of competing vegetation are needed for successful establishment of planted seedlings.
• Regeneration is most successful if trees are harvested in winter.
• Disturbance of the surface layer can limit regeneration of aspen by reducing the fertility of the soil and damaging the parent roots of trees.
• Loose sand interferes with the traction of wheeled equipment.

Interpretive Groups

Land capability classification: IIIe
Woodland ordination symbol: 6S

126—Graycalm loamy sand

Composition

Graycalm soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and convex areas
Landform: Outwash plains
Slope: 0 to 3 percent
Shape of areas: Irregular
Size of areas: 10 to 80 acres

Typical Profile

0 to 9 inches—very dark grayish brown loamy sand
9 to 14 inches—brown loamy sand
14 to 33 inches—dark yellowish brown sand and coarse sand
33 to 39 inches—brown gravelly coarse sand
39 to 44 inches—yellowish brown sand
44 to 60 inches—brown, calcareous sand

Soil Properties and Qualities

Drainage class: Somewhat excessively drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Moderately low or low
Surface runoff: Slow
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The somewhat poorly drained Meehan soils along the outer edges of depressions and swales
• Very poorly drained and poorly drained soils in depressions
Similar inclusions:
• Soils that have more clay
• Soils that are moderately well drained
• Soils that are sandy to a depth of more than 40 inches or less than 20 inches
• Soils that have a surface layer of loamy coarse sand

Use and Management

Cropland:
• Planting cover crops and windbreaks, using conservation tillage systems that keep crop residue on the surface, and stripcropping conserve moisture and help to control soil blowing.

• Irrigation is not practical for most crops because of the rapid permeability.
Pasture and forage:
• Overgrazing increases the hazard of soil blowing and reduces the quality of pastures.
• Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing help to keep the pastures in fair condition.
Woodland:
• Adequate site preparation and control of plant competition by applying herbicides or mechanically removing undesirable plants are needed to establish new stands.

Interpretive Groups

Land capability classification: IVs
Woodland ordination symbol: 6A

139B—Huntersville loamy fine sand, 1 to 6 percent slopes

Composition

Huntersville soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane, slightly concave, and convex areas
Landform: Drumlins
Shape of areas: Oblong
Size of areas: 5 to 60 acres

Typical Profile

0 to 7 inches—very dark gray loamy fine sand
7 to 12 inches—dark brown loamy sand
12 to 24 inches—yellowish brown cobbly loamy sand
24 to 60 inches—yellowish brown, mottled sandy loam

Soil Properties and Qualities

Drainage class: Moderately well drained
Permeability: Rapid in the upper part; moderately slow to very slow in the lower part
Available water capacity: Low
Organic matter content: Moderately low or moderate
Surface runoff: Slow
Depth to the water table: 2.5 to 4.0 feet
Other characteristics: Root-restricting layer at a depth of 40 inches

Inclusions

Contrasting inclusions:
• Very poorly drained soils in strongly concave areas and in the lower areas
• The excessively drained Menahga and Nymore soils, which are in the higher areas and do not have glacial till within a depth of 60 inches
• The poorly drained Roscommon and Staples soils in slightly concave areas and in the lower areas
Similar inclusions:
• Soils that have abundant cobbles and stones on the surface
• Soils that have a surface layer of loamy sand, sand, or fine sand

Use and Management

Cropland:
• Using conservation tillage systems that keep crop residue on the surface and growing cover crops conserve moisture, help to control soil blowing, and maintain the organic matter content of the plow layer.
• Irrigation may be needed to overcome droughtiness if costly specialty crops are grown.
Pasture and forage:
• Overgrazing increases the runoff rate and reduces the quality of pastures.
• Proper stocking rates, deferment of grazing during wet periods, applications of fertilizer, weed control, and rotation grazing in summer help to keep the pastures in good condition.
Woodland:
• The use of standard planting and logging equipment should be restricted during spring thaw and other wet periods.
• Timber should be harvested when the soil is dry or frozen.
• Adequate site preparation and control of competing vegetation are needed for successful establishment of planted seedlings.

Interpretive Groups

Land capability classification: IIIs
Woodland ordination symbol: 6L

187—Haug muck

Composition

Haug soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Concave areas and depressions in interdrumlin areas
Landform: Ground moraines
Slope: 0 to 1 percent
Shape of areas: Elongated
Size of areas: 4 to 30 acres

Typical Profile

0 to 12 inches—black muck
12 to 16 inches—black loam
16 to 60 inches—olive gray, mottled, calcareous sandy loam

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Moderate or moderately rapid in the upper part; moderate in the lower part
Available water capacity: Very high
Organic matter content: Very high
Surface runoff: Very slow or ponded
Depth to the water table: 1 foot above to 3 feet below the surface

Inclusions

Contrasting inclusions:
• The very poorly drained Markey, Rifle, and Seelyeville soils, which are near the center of depressions and have more than 16 inches of organic material
• The somewhat poorly drained Paddock soils, which are in the higher areas and do not have a surface layer of muck
Similar inclusions:
• Soils that have less than 8 inches or more than 16 inches of muck
• Soils that are sandy below the layer of muck
• Soils that are poorly drained and do not have a surface layer of muck

Use and Management

Pasture and forage:
• Installing a drainage system and seeding palatable forage plants improve pastures.
• Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pastures in good condition.

Interpretive Groups

Land capability classification: IIIw, drained; VIw, undrained
Woodland ordination symbol: Not assigned

207A—Nymore loamy sand, 1 to 3 percent slopes

Composition

Nymore soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and slightly convex areas
Landform: Outwash plains
Shape of areas: Irregular
Size of areas: 5 to 80 acres

Typical Profile

0 to 8 inches—very dark grayish brown loamy sand
8 to 11 inches—brown and dark brown sand
11 to 23 inches—dark yellowish brown sand
23 to 33 inches—yellowish brown sand
33 to 60 inches—light yellowish brown sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Moderately low or moderate
Surface runoff: Slow
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The moderately well drained Duelm and Oylen soils in the lower areas
Similar inclusions:
• Soils that have more gravel or clay
• Soils that have carbonates within a depth of 48 inches
• Soils that have a surface layer of sand or sandy loam

Use and Management

Cropland:
• Planting crops that mature early allows for the most efficient use of moisture.
• Planting cover crops and windbreaks (fig. 4), using conservation tillage systems that keep crop residue on the surface, planting green manure crops, and stripcropping conserve moisture, help to control soil blowing, and increase the organic matter content of the plow layer.
Pasture and forage:
• Overgrazing reduces the quality of pastures and increases the hazard of soil blowing.
• Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing in summer help to keep the pastures in good condition.
Woodland:
• The poor seedling survival rate during dry years can be improved by carefully planting vigorous nursery stock and protecting the seedlings from desiccating winds.
• Adequate site preparation and control of competing vegetation are needed for successful establishment of planted seedlings.
• Regeneration is most successful if trees are harvested in winter.

Figure 4.—Field windbreaks help to protect crops from damaging winds.

Interpretive Groups

Land capability classification: IVs
Woodland ordination symbol: 6S

207B—Nymore loamy sand, 3 to 6 percent slopes

Composition

Nymore soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and slightly convex areas
Landform: Outwash plains
Shape of areas: Narrow and irregular
Size of areas: 5 to 25 acres

Typical Profile

0 to 9 inches—very dark grayish brown loamy sand
9 to 58 inches—dark yellowish brown loamy sand and yellowish brown sand
58 to 60 inches—yellowish brown coarse sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Moderately low or moderate
Surface runoff: Slow
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The moderately well drained Duelm and Oylen soils in the lower areas
• The poorly drained and very poorly drained Forada soils in slightly concave areas and depressions
• The poorly drained Isan soils in slightly concave areas and depressions
Similar inclusions:
• Soils that have more gravel or clay
• Soils that have carbonates within a depth of 48 inches
• Soils that have a surface layer of sand or sandy loam

Use and Management

Cropland:
• Planting crops that mature early allows for the most efficient use of moisture.
• Planting cover crops and windbreaks, using

conservation tillage systems that keep crop residue on the surface, growing green manure crops, and stripcropping conserve moisture, help to control soil blowing, and increase the organic matter content of the plow layer.
Pasture and forage:
• Overgrazing reduces the quality of pastures and increases the hazard of soil blowing.
• Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing in summer help to keep the pastures in good condition.
Woodland:
• The poor seedling survival rate during dry years can be improved by carefully planting vigorous nursery stock and protecting the seedlings from desiccating winds.
• Seedlings grow well if competing vegetation is controlled by applying herbicides or is removed mechanically.

Interpretive Groups

Land capability classification: IVs
Woodland ordination symbol: 6S

207C—Nymore loamy sand, 6 to 12 percent slopes

Composition

Nymore soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Convex areas
Landform: Outwash plains
Shape of areas: Narrow and irregular
Size of areas: 5 to 20 acres

Typical Profile

0 to 5 inches—black loamy sand
5 to 9 inches—dark brown loamy sand
9 to 25 inches—dark yellowish brown sand
25 to 60 inches—yellowish brown and strong brown coarse sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Moderately low or moderate
Surface runoff: Medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The moderately well drained Duelm and Oylen soils in the lower areas
• The poorly drained and very poorly drained Forada soils in slightly concave areas and depressions
• The poorly drained Isan soils in slightly concave areas and depressions
Similar inclusions:
• Soils that have more gravel or clay
• Soils that have carbonates within a depth of 48 inches
• Soils that have a surface layer of sand or sandy loam

Use and Management

Cropland:
• Planting crops that mature early allows for the most efficient use of moisture.
• Planting cover crops and windbreaks, using conservation tillage systems that keep crop residue on the surface, growing green manure crops, and stripcropping conserve moisture, help to control soil blowing and water erosion, and increase the organic matter content of the plow layer.
Pasture and forage:
• Overgrazing increases the hazards of water erosion and soil blowing and reduces the quality of pastures.
• Interseeding with suitable plants can improve the quality of the pastures.
• Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing in summer help to keep the pastures in good condition.
Woodland:
• The poor seedling survival rate during dry years can be improved by carefully planting vigorous nursery stock and protecting the seedlings from desiccating winds.
• Seedlings grow well if competing vegetation is controlled by applying herbicides or is removed mechanically.

Interpretive Groups

Land capability classification: IVs
Woodland ordination symbol: 6S

260—Duelm loamy sand

Composition

Duelm soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and slightly concave areas on broad flats and low rises

Landform: Outwash plains
Slope: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 5 to 50 acres

Typical Profile

0 to 9 inches—very dark brown loamy sand
9 to 12 inches—very dark grayish brown loamy sand
12 to 24 inches—dark yellowish brown sand
24 to 29 inches—dark yellowish brown, mottled sand
29 to 36 inches—dark yellowish brown and dark brown, mottled sand
36 to 60 inches—dark grayish brown and light brownish gray, mottled sand

Soil Properties and Qualities

Drainage class: Moderately well drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Moderate or high
Surface runoff: Slow
Depth to the water table: 2 to 5 feet

Inclusions

Contrasting inclusions:
• The very poorly drained and poorly drained Forada soils in concave areas and in the lower areas
• The poorly drained Isan soils in concave areas and in the lower areas
• The very poorly drained Leafriver soils in concave areas and in the lower areas
Similar inclusions:
• Soils that have more clay or gravel in the profile
• Soils that have iron stains and concretions between depths of 12 and 36 inches
• Soils that have a surface layer of loamy coarse sand, coarse sand, or sand

Use and Management

Cropland:
• Planting crops that mature early allows for the most efficient use of moisture.
• The seasonal high water table provides moisture for some deep-rooted plants.
• Because of the rapid permeability, irrigation is not practical for most crops.
• Stripcropping, growing green manure crops, using conservation tillage systems that keep crop residue on the surface, and planting cover crops conserve moisture, help to control soil blowing, and increase the organic matter content of the plow layer.
Pasture and forage:
• Overgrazing increases the hazard of soil blowing and reduces the quality of pastures.
• Proper stocking rates, deferment of grazing during dry periods, applications of fertilizer, weed control, and rotation grazing in summer help to keep the pastures in good condition.
Woodland:
• Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the windthrow hazard.
• Seedlings grow best if competing vegetation is controlled by applying herbicides or is removed mechanically.

Interpretive Groups

Land capability classification: IVs
Woodland ordination symbol: 6W

261—Isan loamy sand

Composition

Isan soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and slightly concave areas on broad flats
Landform: Outwash plains
Slope: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 10 to 160 acres

Typical Profile

0 to 13 inches—black loamy sand
13 to 21 inches—very dark grayish brown, mottled sand
21 to 30 inches—dark grayish brown, mottled sand
30 to 60 inches—grayish brown, mottled sand

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Moderate or high
Surface runoff: Slow
Depth to the water table: 0.5 foot to 2.0 feet

Inclusions

Contrasting inclusions:
• Very poorly drained organic soils in the center of depressions
• The well drained Dorset and Verndale soils, which have more clay in the subsoil than the Isan soil and are in the higher areas
• The moderately well drained Oylen soils, which have more clay in the subsoil than the Isan soil and are in the higher areas

• The somewhat excessively drained Nymore soils in the higher areas
• The moderately well drained Duelm soils in the higher areas
Similar inclusions:
• Soils that are somewhat poorly drained or very poorly drained
• Soils that have brighter colors in the lower part
• Soils that have more gravel or clay in the profile
• Soils that have a mucky surface layer

Use and Management

Cropland:
• Drainage is difficult because most of the unit is in low-lying areas.
• Soil blowing can be controlled by planting windbreaks and by using conservation tillage systems that keep crop residue on the surface.
• Using conservation tillage systems, planting cover crops, and returning crop residue to the soil help to maintain tilth and the content of organic matter.
Pasture and forage:
• The best suited species are those that can tolerate wetness.
• Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep pastures in good condition.

Interpretive Groups

Land capability classification: IVw
Woodland ordination symbol: Not assigned

374B—Rockwood sandy loam, 2 to 6 percent slopes

Composition

Rockwood soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Slightly convex and plane areas
Landform: Drumlins
Shape of areas: Irregular
Size of areas: 5 to 60 acres

Typical Profile

0 to 6 inches—very dark gray sandy loam
6 to 14 inches—yellowish brown sandy loam
14 to 26 inches—yellowish brown and dark yellowish brown loamy sand
26 to 48 inches—yellowish brown sandy loam
48 to 60 inches—yellowish brown, calcareous sandy loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate in the upper part; moderately slow to very slow in the lower part
Available water capacity: Moderate
Organic matter content: Moderate
Surface runoff: Medium
Depth to the water table: More than 6 feet
Other characteristics: Stones in the upper part in some areas; root-restricting layer at a depth of 48 inches

Inclusions

Contrasting inclusions:
• The excessively drained Menahga soils, which have a till substratum or are sandy to a depth of 40 inches or more
• The somewhat poorly drained Paddock soils in drainageways and depressions
• The very poorly drained Runeberg soils in drainageways and depressions
Similar inclusions:
• Soils that have a thicker, more clayey subsoil
• Soils that have small pockets or seams of sand and gravel in the subsoil and substratum
• Soils that are moderately well drained
• Soils that have a surface layer of fine sandy loam or loam

Use and Management

Cropland:
• Using conservation tillage systems that keep crop residue on the surface, farming on the contour, installing diversions and grassed waterways, and stripcropping with grasses and legumes help to control erosion and improve or maintain the tilth and organic matter content of the plow layer.
Pasture and forage:
• Maintaining a cover of grasses and legumes helps to control erosion.
• Overgrazing or grazing when the soil is wet results in compaction of the surface layer and excessive runoff and increases the hazard of water erosion.
• Proper stocking rates, applications of fertilizer, weed control, rotation grazing, deferment of grazing until the grasses reach a minimum height, and restricted grazing during wet periods help to keep pastures in good condition.
Woodland:
• The use of standard planting and logging equipment should be restricted during spring thaw and other wet periods.
• Seedlings grow well if competing vegetation is

controlled by applying herbicides or is removed mechanically.

Interpretive Groups

Land capability classification: IIe
Woodland ordination symbol: 4L

374C—Rockwood sandy loam, 6 to 12 percent slopes

Composition

Rockwood soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and convex areas on side slopes
Landform: Drumlins
Shape of areas: Elongated
Size of areas: 5 to 60 acres

Typical Profile

0 to 4 inches—very dark grayish brown sandy loam
4 to 19 inches—very dark grayish brown and brown sandy loam
19 to 26 inches—dark yellowish brown gravelly sandy loam
26 to 37 inches—dark yellowish brown sandy loam
37 to 55 inches—yellowish brown sandy loam
55 to 60 inches—yellowish brown, calcareous sandy loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate in the upper part; moderately slow to very slow in the lower part
Available water capacity: Moderate
Organic matter content: Moderate
Surface runoff: Medium or rapid
Depth to the water table: More than 6 feet
Other characteristics: Root-restricting layer at a depth of 55 inches

Inclusions

Contrasting inclusions:
• The somewhat poorly drained Paddock soils in concave areas
• The very poorly drained Runeberg soils in shallow depressions
Similar inclusions:
• Soils that have a thicker, more clayey subsoil
• Soils that have small pockets or seams of sand and gravel in the subsoil and substratum
• Soils that are moderately well drained
• Soils that have a surface layer of fine sandy loam or loam

Use and Management

Cropland:
• Stripcropping with grasses and legumes helps to control surface runoff and erosion.
• Using conservation tillage systems that keep crop residue on the surface, farming on the contour, installing terraces, diversions, and grassed waterways, returning crop residue to the soil, and planting cover crops help to control runoff and erosion and maintain tilth.
Pasture and forage:
• Overgrazing or grazing when the soil is wet results in compaction of the surface layer and excessive runoff and increases the hazard of erosion.
• Proper stocking rates, rotation grazing, applications of fertilizer, weed control, deferment of grazing until the grasses reach a minimum height, and restricted grazing during wet periods help to keep pastures in good condition.
Woodland:
• The use of standard planting and logging equipment should be restricted during spring thaw and other wet periods.
• Seedlings grow well if competing vegetation is controlled by applying herbicides or is removed mechanically.

Interpretive Groups

Land capability classification: IIIe
Woodland ordination symbol: 4L

374D—Rockwood sandy loam, 12 to 18 percent slopes

Composition

Rockwood soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and convex areas on side slopes
Landform: Drumlins
Shape of areas: Elongated
Size of areas: 5 to 25 acres

Typical Profile

0 to 4 inches—black sandy loam
4 to 13 inches—dark brown sandy loam
13 to 33 inches—brown and dark yellowish brown loamy sand
33 to 43 inches—yellowish brown sandy loam

43 to 60 inches—yellowish brown, calcareous sandy loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate in the upper part; moderately slow to very slow in the lower part
Available water capacity: Moderate
Organic matter content: Moderate
Surface runoff: Rapid
Depth to the water table: More than 6 feet
Other characteristics: Root-restricting layer at a depth of 43 inches

Inclusions

Contrasting inclusions:
• The somewhat poorly drained Paddock soils in concave areas
Similar inclusions:
• Soils that have a thicker, more clayey subsoil
• Soils that have small pockets or seams of sand and gravel in the subsoil and substratum
• Soils that are moderately well drained
• Soils that have a surface layer of fine sandy loam or loam

Use and Management

Cropland:
• Stripcropping with grasses and legumes helps to control surface runoff and erosion.
• Using conservation tillage systems that keep crop residue on the surface, farming on the contour, installing terraces, diversions, and grassed waterways, returning crop residue to the soil, and planting cover crops help to control runoff and erosion and maintain tilth.
Pasture and forage:
• Overgrazing or grazing when the soil is wet results in compaction of the surface layer and excessive runoff and increases the hazard of erosion.
• Proper stocking rates, rotation grazing, applications of fertilizer, weed control, deferment of grazing until the grasses reach a minimum height, and restricted grazing during wet periods help to keep pastures in good condition.
Woodland:
• The use of standard planting and logging equipment should be restricted during spring thaw and other wet periods.
• Constructing logging roads and trails on the contour helps to control erosion.
• Seedlings grow well if competing vegetation is controlled by applying herbicides or is removed mechanically.

Interpretive Groups

Land capability classification: IVe
Woodland ordination symbol: 4R

375—Forada loam

Composition

Forada soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and slightly concave areas on the edges of depressions and drainageways
Landforms: Outwash plains, moraines
Slope: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 5 to 40 acres

Typical Profile

0 to 11 inches—black loam
11 to 15 inches—very dark gray, mottled loam
15 to 20 inches—olive gray, mottled loam
20 to 25 inches—olive gray, mottled sandy loam
25 to 32 inches—dark grayish brown, mottled coarse sand
32 to 60 inches—grayish brown, mottled, calcareous coarse sand

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Moderate or moderately rapid in the upper part; rapid in the lower part
Available water capacity: Low
Organic matter content: High or very high
Surface runoff: Slow
Depth to the water table: 1 to 3 feet

Inclusions

Contrasting inclusions:
• Very poorly drained soils that have a muck surface layer more than 8 inches thick and are near the center of depressions
• The moderately well drained Oylen soils on convex rises and in the higher areas
• The well drained Verndale soils on convex rises and in the higher areas
• The somewhat poorly drained Paddock soils, which have a glacial till subsoil and are in the higher areas adjacent to glacial drumlins
• The somewhat excessively drained Nymore soils in the higher areas
Similar inclusions:
• Soils that have thin layers of loamy material in the lower part

- Soils that have a thinner surface layer
- Soils that have carbonates at a shallower depth
- Soils that have a surface layer of sandy loam

Use and Management

Cropland:
- Excess water can be removed with open ditches, subsurface drains, or both.
- If subsurface drains are used, extra precautions are needed to keep sand from entering the tile lines.
- Drainage is difficult because most of the unit is in low-lying areas.

Pasture and forage:
- The best suited grasses are those that can tolerate wetness.
- Overgrazing when the soil is wet results in compaction of the surface layer and reduces the quality of pastures.
- Proper stocking rates, rotation grazing, applications of fertilizer, weed control, timely deferment of grazing, and restricted grazing during wet periods help to keep the pastures in good condition.

Interpretive Groups

Land capability classification: IIw
Woodland ordination symbol: Not assigned

406A—Dorset sandy loam, 1 to 3 percent slopes

Composition

Dorset soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and convex areas
Landform: Outwash plains
Shape of areas: Irregular
Size of areas: 5 to 40 acres

Typical Profile

0 to 9 inches—black sandy loam
9 to 16 inches—dark yellowish brown sandy loam
16 to 21 inches—dark yellowish brown gravelly loamy sand
21 to 30 inches—dark yellowish brown gravelly sand
30 to 60 inches—pale brown, calcareous gravelly coarse sand

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderately rapid in the upper part; rapid in the lower part
Available water capacity: Low
Organic matter content: Moderate or high
Surface runoff: Slow
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
- The poorly drained and very poorly drained Forada soils in depressions and swales
- The poorly drained Isan soils in depressions and swales
- The very poorly drained Leafriver soils, which have a mucky surface layer and are near the center of depressions

Similar inclusions:
- Soils that have carbonates below a depth of 36 inches
- Soils that have less clay and gravel between depths of 9 and 16 inches
- Soils that have a darker, thicker surface layer
- Soils that are moderately well drained
- Soils that have a thin surface layer
- Soils that have a surface layer of fine sandy loam

Use and Management

Cropland:
- Because of the limited available water capacity, most crops should be irrigated.
- The best suited crops are those that can withstand drought. The amount of moisture available is not adequate for good growth of other crops.
- Stripcropping, planting green manure crops, applying manure, using conservation tillage systems that keep crop residue on the surface, and planting cover crops conserve moisture, help to control soil blowing, and maintain the organic matter content of the plow layer.

Pasture and forage:
- Overgrazing reduces the quality of pastures and increases the hazard of soil blowing.
- Proper stocking rates, deferment of grazing during dry periods, applications of fertilizer, weed control, and rotation grazing in summer help to keep the pastures in good condition.

Woodland:
- The poor seedling survival rate during dry years can be improved by carefully planting vigorous nursery stock and protecting the seedlings from desiccating winds.
- Competing weeds should be controlled by applying herbicides or should be removed mechanically.

Interpretive Groups

Land capability classification: IIIs
Woodland ordination symbol: 2A

406B—Dorset sandy loam, 3 to 6 percent slopes

Composition

Dorset soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Convex areas and knolls
Landform: Outwash plains
Shape of areas: Irregular
Size of areas: 5 to 40 acres

Typical Profile

0 to 8 inches—black sandy loam
8 to 15 inches—dark yellowish brown sandy loam
15 to 30 inches—dark yellowish brown gravelly sand
30 to 60 inches—yellowish brown, calcareous gravelly sand

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderately rapid in the upper part; rapid in the lower part
Available water capacity: Low
Organic matter content: Moderate or high
Surface runoff: Medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The poorly drained and very poorly drained Forada soils in depressions and swales
• The poorly drained Isan soils in depressions and swales
• The very poorly drained Leafriver soils, which have a mucky surface layer and are near the center of depressions
Similar inclusions:
• Soils that have carbonates below a depth of 36 inches
• Soils that have less clay or gravel between depths of 8 and 15 inches
• Soils that have a darker, thicker surface layer
• Soils that are moderately well drained
• Soils that have a thin surface layer
• Soils that have a surface layer of fine sandy loam

Use and Management

Cropland:
• Because of the limited available water capacity, most crops should be irrigated.
• The best suited crops are those that can withstand drought. The amount of moisture available is not adequate for good growth of other crops.
• Stripcropping, planting green manure crops, spreading manure, using conservation tillage systems that keep crop residue on the surface, and planting cover crops conserve moisture, help to control soil blowing, and maintain the organic matter content of the plow layer.
Pasture and forage:
• Overgrazing reduces the quality of pastures and increases the hazard of soil blowing.
• Proper stocking rates, deferment of grazing during dry periods, applications of fertilizer, weed control, and rotation grazing in summer help to keep the pastures in good condition.
Woodland:
• The poor seedling survival rate during dry years can be improved by carefully planting vigorous nursery stock and protecting the seedlings from desiccating winds.
• Competing weeds should be controlled by applying herbicides or should be removed mechanically.

Interpretive Groups

Land capability classification: IIIs
Woodland ordination symbol: 2A

454B—Mahtomedi loamy sand, 1 to 8 percent slopes

Composition

Mahtomedi soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and convex areas
Landforms: Outwash plains and drumlins
Shape of areas: Irregular
Size of areas: 5 to 40 acres

Typical Profile

0 to 8 inches—very dark grayish brown loamy sand
8 to 18 inches—strong brown gravelly sand
18 to 31 inches—dark yellowish brown sand
31 to 35 inches—dark yellowish brown gravelly sand
35 to 60 inches—brown, calcareous gravelly sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Very low or low
Surface runoff: Slow
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The moderately well drained Blowers soils, which

formed in glacial till and are on drumlins
• The somewhat poorly drained Meehan soils, which are in the lower areas and have less gravel
• The poorly drained Roscommon soils, which are in the lower areas and have less gravel
Similar inclusions:
• Soils that have more gravel or clay in the profile
• Soils that are moderately well drained

Use and Management

Cropland:
• Crops that mature early are best suited because of the abundant moisture received late in spring.
• Planting cover crops and windbreaks, growing green manure crops, and using conservation tillage systems that keep crop residue on the surface help to control water erosion and soil blowing and maintain the organic matter content of the plow layer.
Pasture and forage:
• Overgrazing increases the hazard of water erosion and reduces the quality of pastures.
• Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing in summer help to keep the pastures in fair condition.
Woodland:
• The poor seedling survival rate during dry years can be improved by carefully planting vigorous nursery stock and protecting the seedlings from desiccating winds.
• Seedlings grow well if competing vegetation is controlled by applying herbicides or is removed mechanically.
• Loose sand interferes with the traction of wheeled equipment.

Interpretive Groups

Land capability classification: IVs
Woodland ordination symbol: 6S

458A—Menahga loamy sand, 0 to 2 percent slopes

Composition

Menahga soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and slightly concave areas on broad flats
Landform: Outwash plains
Shape of areas: Irregular
Size of areas: 5 to 120 acres

Typical Profile

0 to 2 inches—very dark gray loamy sand
2 to 5 inches—dark grayish brown loamy sand
5 to 37 inches—dark yellowish brown and yellowish brown sand
37 to 60 inches—light yellowish brown sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Moderately low or low
Surface runoff: Slow
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The moderately well drained Friendship soils in concave areas and in the lower areas
• The somewhat poorly drained Meehan soils in concave areas and in the lower areas
• The very poorly drained Leafriver and Markey soils, which have a mucky surface layer and are near the center of depressions
• The poorly drained Roscommon soils in or adjacent to depressions
Similar inclusions:
• Soils that have more clay or gravel in the profile
• Soils that have a thicker surface layer

Use and Management

Cropland:
• Planting cover crops and windbreaks, using conservation tillage systems that keep crop residue on the surface, and stripcropping conserve moisture and help to control soil blowing.
Pasture and forage:
• Overgrazing increases the hazard of soil blowing and reduces the quality of pastures.
• Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing in summer help to keep the pastures in fair condition.
Woodland:
• The seedling survival rate can be improved by carefully planting vigorous nursery stock. Trees suitable for planting are those that can tolerate droughtiness.
• Windbreaks help to protect seedlings from desiccating winds.
• Loose sand interferes with the traction of wheeled equipment.

Interpretive Groups

Land capability classification: IVs
Woodland ordination symbol: 6S

458B—Menahga loamy coarse sand, 2 to 6 percent slopes

Composition

Menahga soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and convex areas
Landform: Outwash plains
Shape of areas: Irregular
Size of areas: 5 to 160 acres

Typical Profile

0 to 2 inches—black loamy coarse sand
2 to 4 inches—very dark grayish brown coarse sand
4 to 19 inches—dark brown and dark yellowish brown coarse sand
19 to 24 inches—brown coarse sand
24 to 60 inches—pale brown coarse sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Moderately low or low
Surface runoff: Slow
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The moderately well drained Friendship soils in concave areas and in the lower areas
• The somewhat poorly drained Meehan soils in concave areas and in the lower areas
• The very poorly drained Leafriver and Markey soils, which have a mucky surface layer and are near the center of depressions
• The poorly drained Roscommon soils in or adjacent to depressions
Similar inclusions:
• Soils that have more clay or gravel in the profile
• Soils that have a thicker surface layer

Use and Management

Cropland:
• Planting cover crops and windbreaks and using conservation tillage systems that keep crop residue on the surface conserve moisture and help to control soil blowing.
Pasture and forage:
• Overgrazing increases the hazard of soil blowing and reduces the quality of pastures.
• Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing in summer help to keep the pastures in good condition.
Woodland:
• The seedling survival rate can be improved by carefully planting vigorous nursery stock. Trees suitable for planting are those that can tolerate droughtiness.
• Windbreaks help to protect seedlings from desiccating winds.
• Loose sand interferes with the traction of wheeled equipment.

Interpretive Groups

Land capability classification: IVs
Woodland ordination symbol: 6S

458C—Menahga loamy sand, 6 to 15 percent slopes

Composition

Menahga soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and convex areas near drainageways and adjacent to lakes
Landform: Outwash plains
Shape of areas: Irregular
Size of areas: 5 to 25 acres

Typical Profile

0 to 4 inches—very dark gray loamy sand
4 to 13 inches—dark brown and dark grayish brown sand
13 to 49 inches—dark yellowish brown sand and dark brown coarse sand
49 to 60 inches—yellowish brown sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Low or moderately low
Surface runoff: Medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The moderately well drained Friendship soils in concave areas and in the lower areas
• The somewhat poorly drained Meehan soils in concave areas and in the lower areas
• The very poorly drained Leafriver soils in concave areas and in depressions

• The poorly drained Roscommon soils in concave areas and in depressions
• The well drained Redeye soils, which have glacial till within a depth of 40 inches
Similar inclusions:
• Soils that have more clay or gravel in the profile
• Soils that have a thicker surface layer

Use and Management

Cropland:
• Planting cover crops and windbreaks, using conservation tillage systems that keep crop residue on the surface, and stripcropping on the contour conserve moisture, help to control soil blowing, and reduce the hazard of water erosion.
Pasture and forage:
• Overgrazing increases the hazard of soil blowing and reduces the quality of pastures.
• Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing in summer help to keep the pastures in good condition.
Woodland:
• The seedling survival rate can be improved by carefully planting vigorous nursery stock. Trees suitable for planting are those that can tolerate droughtiness.
• Windbreaks help to protect seedlings from desiccating winds.
• Loose sand and the slope interfere with the traction of wheeled equipment.

Interpretive Groups

Land capability classification: IVs
Woodland ordination symbol: 6S

458E—Menahga loamy sand, 15 to 45 percent slopes

Composition

Menahga soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Convex areas, escarpments, and side slopes adjacent to lakes, rivers, and river bottoms
Landform: Outwash plains
Shape of areas: Elongated
Size of areas: 5 to 50 acres

Typical Profile

0 to 2 inches—very dark gray loamy sand
2 to 6 inches—dark grayish brown loamy sand
6 to 38 inches—brown and yellowish brown sand
38 to 60 inches—light yellowish brown sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Moderately low or low
Surface runoff: Rapid
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The poorly drained and very poorly drained Evart soils on the flood plains of streams
• The moderately well drained Friendship soils in concave areas on foot slopes and on stream terraces
• The somewhat poorly drained Meehan soils in concave areas on foot slopes and on stream terraces
• The very poorly drained Leafriver and Markey soils on foot slopes and in shallow depressions adjacent to escarpments
Similar inclusions:
• Soils that have more clay or gravel in the profile
• Soils that have a thicker surface layer

Use and Management

Woodland:
• Constructing logging roads and trails on the contour helps to control erosion.
• The use of equipment is limited by the slope and by snow, which restricts traction.
• Adequate site preparation and careful planting of vigorous nursery stock improve the poor seedling survival rate.
• Loose sand and the slope interfere with the traction of wheeled equipment.

Interpretive Groups

Land capability classification: VIIs
Woodland ordination symbol: 6R

540—Seelyeville muck

Composition

Seelyeville soil and similar inclusions—85 to 90 percent
Contrasting inclusions—10 to 15 percent

Setting

Landscape position: Plane and slightly concave areas near the center of depressions; interdrumlin areas
Landforms: Outwash plains, ground moraines
Slope: 0 to 2 percent
Shape of areas: Circular or oblong
Size of areas: 15 to 200 acres

Typical Profile

0 to 60 inches—black muck

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Moderately slow to moderately rapid
Available water capacity: Very high
Organic matter content: Very high
Surface runoff: Very slow or ponded
Depth to the water table: 2 feet above to 2 feet below the surface

Inclusions

Contrasting inclusions:
• The very poorly drained Forada, Haug, Leafriver, and Runeberg soils, which have less than 16 inches of muck over loamy or sandy material and are along the outer edges of broad depressions in the slightly higher areas
• The poorly drained Isan and Roscommon soils on the edges of depressions in the higher areas
Similar inclusions:
• Soils that are nonacid in the upper part
• Soils that have limnic deposits in the lower part

Use and Management

Pasture and forage:
• Installing a drainage system and seeding plants that can tolerate wetness improve pastures.
• Controlling brush and deferring grazing when the soil is wet and until the forage is at an optimum height help to keep the pastures in good condition.

Interpretive Groups

Land capability classification: VIw
Woodland ordination symbol: Not assigned

541—Rifle mucky peat

Composition

Rifle soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and slightly concave areas near the center of broad depressions; interdrumlin areas
Landforms: Outwash plains, ground moraines
Slope: 0 to 2 percent
Shape of areas: Circular or oblong
Size of areas: 15 to 200 acres

Typical Profile

0 to 60 inches—very dark brown mucky peat

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Moderate or moderately rapid
Available water capacity: Very high
Organic matter content: Very high
Surface runoff: Very slow or ponded
Depth to the water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• The very poorly drained Forada, Haug, Leafriver, and Runeberg soils, which have less than 16 inches of muck over loamy or sandy material and are along the outer edges of broad depressions in the slightly higher areas
• The poorly drained Isan and Roscommon soils on the edges of depressions in the higher areas
Similar inclusions:
• Soils that are less acid
• Soils that are underlain by loamy or sandy material
• Soils that are black muck throughout
• Soils that have a fibrous surface layer
• Soils that have limnic deposits

Use and Management

Pasture and forage:
• Installing a drainage system and seeding plants that can tolerate wetness improve pastures.
• Contolling brush and deferring grazing until the forage is at an optimum height help to keep the pastures in good condition.
Woodland:
• The use of equipment is restricted during wet periods because the soil is soft and cannot support heavy equipment.
• Planting water-tolerant species reduces the seedling mortality rate.
• Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the windthrow hazard.
• Seedlings grow well if competing vegetation is controlled by applying herbicides or is removed mechanically.

Interpretive Groups

Land capability classification: VIw, undrained; IVw, drained
Woodland ordination symbol: 3W

543—Markey muck

Composition

Markey soil and similar inclusions—85 to 95 percent

Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and slightly concave areas near the center of depressions and along the outer edges of large bogs
Landforms: Outwash plains, ground moraines, interdrumlin areas
Slope: 0 to 2 percent
Shape of areas: Circular or oblong
Size of areas: 5 to 120 acres

Typical Profile

0 to 26 inches—black muck
26 to 29 inches—pale olive loam
29 to 60 inches—greenish gray, calcareous sand

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Moderately slow to moderately rapid in the upper part; rapid in the lower part
Available water capacity: Very high
Organic matter content: Very high
Surface runoff: Very slow or ponded
Depth to the water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• The poorly drained and very poorly drained Forada soils, which have a layer of organic material less than 8 inches thick or do not have a layer of organic material
• The poorly drained Isan and Roscommon soils, which do not have a layer of organic material
• The very poorly drained Runeberg soils, which have a layer of organic material less than 8 inches thick or do not have a layer of organic material
Similar inclusions:
• Soils that are underlain by limnic deposits
• Soils that are underlain by loamy mineral material
• Soils that have more undecomposed organic material in the profile

Use and Management

Pasture and forage:
• Installing a drainage system (fig. 5) and seeding plants that can tolerate wetness improve pastures.
• Controlling brush and deferring grazing when the soil is wet and until the forage is at an optimum height help to keep the pastures in good condition.

Interpretive Groups

Land capability classification: VIw, undrained; IVw, drained
Woodland ordination symbol: Not assigned

544—Cathro muck

Composition

Cathro soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and slightly concave areas near the center of depressions and along the outer edges of large bogs
Landforms: Outwash plains, ground moraines, interdrumlin areas
Slope: 0 to 2 percent
Shape of areas: Elongated, circular, or oblong
Size of areas: 5 to 120 acres

Typical Profile

0 to 26 inches—black muck
26 to 35 inches—black mucky loam
35 to 38 inches—dark gray loam
38 to 60 inches—olive gray, mottled loam

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Moderately rapid to moderately slow in the upper part; moderate or moderately slow in the lower part
Available water capacity: Very high
Organic matter content: Very high
Surface runoff: Very slow or ponded
Depth to the water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• The poorly drained and very poorly drained Forada soils, which have a layer of organic material less than 8 inches thick or do not have a layer of organic material
• The poorly drained Isan and Roscommon soils, which do not have a layer of organic material
• The very poorly drained Runeberg soils, which have a layer of organic material less than 8 inches thick or do not have a layer of organic material
• The somewhat poorly drained Paddock soils along the edges of depressions in the higher areas
Similar inclusions:
• Soils that have more undecomposed organic material in the profile
• Soils that are along streams and rivers and are subject to flooding
• Soils that are underlain by sandy material

Use and Management

Pasture and forage:
• Installing a drainage system and seeding plants that

Figure 5.—If suitable outlets are available, ditches can be used to drain areas of Markey muck.

can tolerate wetness improve pastures.
• Controlling brush and deferring grazing when the soil is wet and until the forage is at an optimum height help to keep the pastures in good condition.

Interpretive Groups

Land capability classification: VIw, undrained; IVw, drained
Woodland ordination symbol: Not assigned

545—Rondeau muck

Composition

Rondeau soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and slightly concave areas in broad depressions and old lake basins
Landform: Bogs
Slope: 0 to 1 percent
Shape of areas: Circular or oblong
Size of areas: 10 to 160 acres

Typical Profile

0 to 38 inches—black muck
38 to 60 inches—olive gray, calcareous marl

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Moderately rapid to moderately slow in the upper part; very slow or slow in the lower part
Available water capacity: Very high
Organic matter content: Very high
Surface runoff: Very slow or ponded
Depth to the water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• The very poorly drained Leafriver soils, which have less than 16 inches of organic material over mineral material and are along the edges of depressions
• The poorly drained and very poorly drained Forada soils, which have a layer of organic material less than 8 inches thick or do not have a layer of organic material
• The poorly drained Isan and Roscommon soils, which

do not have a layer of organic material
• The very poorly drained Runeberg soils, which have a layer of organic material less than 8 inches thick or do not have a layer of organic material
• The somewhat poorly drained Paddock soils along the edges of depressions in the higher areas
Similar inclusions:
• Soils that have more undecomposed organic material in the profile
• Soils that consist of organic material over loamy or sandy material or other limnic deposits
• Soils that have limnic deposits at a depth of less than 16 inches or more than 51 inches

Use and Management

Pasture and forage:
• Installing a drainage system and seeding plants that can tolerate wetness improve pastures.
• Controlling brush and deferring grazing when the soil is wet and until the forage is at an optimum height help to keep the pastures in good condition.

Interpretive Groups

Land capability classification: VIw, undrained; IVw, drained
Woodland ordination symbol: Not assigned

567A—Verndale sandy loam, 0 to 2 percent slopes

Composition

Verndale soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane, slightly concave, and slightly convex areas
Landform: Outwash plains
Shape of areas: Irregular
Size of areas: 5 to 120 acres

Typical Profile

0 to 9 inches—black sandy loam
9 to 13 inches—dark brown sandy loam
13 to 19 inches—brown sandy loam
19 to 28 inches—dark yellowish brown sand
28 to 49 inches—yellowish brown coarse sand
49 to 60 inches—light yellowish brown, calcareous sand

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderately rapid or moderate in the upper part; rapid in the lower part
Available water capacity: Low
Organic matter content: Moderate
Surface runoff: Slow
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Cathro, Forada, Leafriver, and Markey soils in concave areas and depressions
• The poorly drained and very poorly drained Forada soils in slightly concave or plane areas on the lower parts of the landscape
• The poorly drained Isan soils in slightly concave or plane areas on the lower parts of the landscape
Similar inclusions:
• Soils that have less clay in the upper part
• Soils that have carbonates within a depth of 36 inches
• Soils that have more gravel in the profile
• Soils that have a surface layer that is more than 16 inches or less than 7 inches thick
• Soils that are loamy in the lower part of the subsoil and in the substratum

Use and Management

Cropland:
• Because of the limited available water capacity, most crops should be irrigated.
• The best suited crops are those that can tolerate droughtiness. The amount of moisture available is not adequate for good growth of other crops.
• Stripcropping, planting green manure crops, spreading manure, using conservation tillage systems that keep crop residue on the surface, and planting cover crops conserve moisture, help to control soil blowing, and maintain the organic matter content of the plow layer.
Pasture and forage:
• Overgrazing increases the hazard of soil blowing and reduces the quality of pastures.
• Proper stocking rates, deferment of grazing during dry periods, applications of fertilizer, weed control, and rotation grazing in summer help to keep the pastures in good condition.

Interpretive Groups

Land capability classification: IIIs
Woodland ordination symbol: Not assigned

567B—Verndale sandy loam, 2 to 6 percent slopes

Composition

Verndale soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and slightly concave areas
Landform: Outwash plains
Shape of areas: Narrow and irregular
Size of areas: 5 to 20 acres

Typical Profile

0 to 8 inches—very dark brown sandy loam
8 to 16 inches—dark brown and dark yellowish brown sandy loam
16 to 36 inches—dark yellowish brown and yellowish brown sand
36 to 60 inches—light yellowish brown, calcareous sand

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderately rapid or moderate in the upper part; rapid in the lower part
Available water capacity: Low
Organic matter content: Moderate
Surface runoff: Medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The poorly drained and very poorly drained Forada soils in shallow depressions and drainageways in the lower areas
• The poorly drained Isan soils in shallow depressions and drainageways in the lower areas
Similar inclusions:
• Soils that have less clay in the upper part
• Soils that have carbonates within a depth of 36 inches
• Soils that have more gravel in the profile
• Soils that have a surface layer that is more than 16 inches or less than 7 inches thick
• Soils that have a layer of loamy material in the lower part

Use and Management

Cropland:
• Stripcropping, growing green manure crops, spreading manure, using conservation tillage systems that keep crop residue on the surface, and planting cover crops conserve moisture, help to control water erosion and soil blowing, and maintain the organic matter content of the plow layer.
• Because of the limited available water capacity, most crops should be irrigated.
• The best suited crops are those that can tolerate droughtiness. The amount of moisture available is not adequate for good growth of other crops.
Pasture and forage:
• Overgrazing increases the hazards of water erosion and soil blowing and reduces the quality of pastures.
• Proper stocking rates, deferment of grazing during dry periods, applications of fertilizer, weed control, and rotation grazing in summer help to keep the pastures in good condition.

Interpretive Groups

Land capability classification: IIIs
Woodland ordination symbol: Not assigned

701—Runeberg mucky loam

Composition

Runeberg soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and slightly concave areas in drainageways and depressions
Landform: Drumlins
Slope: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 5 to 45 acres

Typical Profile

0 to 3 inches—black mucky loam
3 to 13 inches—very dark gray, mottled loam
13 to 19 inches—dark grayish brown, mottled loam
19 to 26 inches—olive gray, mottled sandy loam
26 to 60 inches—pale olive, mottled, calcareous sandy loam

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Moderately slow or moderate in the upper part; moderately slow or slow in the lower part
Available water capacity: Moderate
Organic matter content: High or very high
Surface runoff: Very slow or ponded
Depth to the water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• The very poorly drained Cathro, Markey, Rifle, and Seelyeville soils
• The somewhat poorly drained Paddock soils in the higher areas
Similar inclusions:
• Soils that have more sand or clay in the subsoil
• Soils that have carbonates at a depth of less than 24 inches or more than 36 inches
• Soils that have a mucky surface layer 8 to 16 inches thick
• Soils that have a surface layer of sandy loam or loam

Use and Management

Pasture and forage:
• Installing a drainage system and seeding plants that can tolerate wetness improve pastures.
• Controlling brush and deferring grazing when the soil is wet and until the forage is at an optimum height help to keep the pastures in good condition.
Woodland:
• The use of equipment is restricted during wet periods because the soil is soft and cannot support heavy equipment.
• Planting water-tolerant species reduces the seedling mortality rate.
• Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the windthrow hazard.
• Seedlings grow well if competing vegetation is controlled by applying herbicides or is removed mechanically.

Interpretive Groups

Land capability classification: VIw, undrained; IIIw, drained
Woodland ordination symbol: 6W

720B—Blowers sandy loam, 1 to 5 percent slopes

Composition

Blowers soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Slightly concave and plane areas on hilltops
Landform: Drumlins
Shape of areas: Elongated
Size of areas: 5 to 100 acres

Typical Profile

0 to 9 inches—very dark grayish brown sandy loam
9 to 25 inches—brown, grayish brown, and dark yellowish brown sandy loam
25 to 32 inches—yellowish brown, mottled sandy clay loam
32 to 49 inches—olive brown, mottled sandy loam
49 to 60 inches—light olive brown, mottled sandy loam

Soil Properties and Qualities

Drainage class: Moderately well drained
Permeability: Moderate in the upper part; moderately slow to very slow in the lower part
Available water capacity: Moderate
Organic matter content: Moderate or high
Surface runoff: Medium
Depth to the water table: 2 to 3 feet
Other characteristics: Root-restricting layer at a depth of 49 inches

Inclusions

Contrasting inclusions:
• The excessively drained Mahtomedi soils, which formed in outwash and are on small knolls
• The very poorly drained Runeberg soils in concave areas and depressions
• The poorly drained Staples soils in concave areas on foot slopes and head slopes in the lower areas
Similar inclusions:
• Soils that have more clay or less sand in the profile
• Soils that are well drained or somewhat poorly drained
• Soils that are sandy in the upper part
• Soils that have gravel in the lower part

Use and Management

Cropland:
• Using conservation tillage systems that keep crop residue on the surface, farming on the contour, constructing diversions and grassed waterways, and stripcropping with grasses and legumes help to control water erosion.
• Returning crop residue to the surface and planting cover crops help to control erosion and improve or maintain the tilth and organic matter content of the plow layer.
Pasture and forage:
• Grazing when the soil is wet results in compaction of the surface layer and excessive runoff and increases the hazard of water erosion.
• Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep pastures in good condition.
Woodland:
• Seedlings grow best if competing vegetation is controlled by applying herbicides or is removed mechanically.
• Trees should be harvested when the soil is dry or frozen.

Interpretive Groups

Land capability classification: IIe
Woodland ordination symbol: 6L

793—Paddock complex

Composition

Paddock loam, very stony, and similar soils—55 to 60 percent

Paddock loam and similar soils—35 to 50 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and slightly concave areas in depressions and shallow drainageways on toe slopes, foot slopes, and head slopes
Landform: Drumlins
Slope: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 5 to 100 acres

Typical Profile

Paddock loam, very stony:
0 to 7 inches—black loam
7 to 17 inches—dark grayish brown, mottled sandy loam
17 to 21 inches—brownish gray, mottled sandy clay loam
21 to 40 inches—light brownish gray and brown, mottled sandy loam
40 to 60 inches—yellowish brown, mottled, calcareous sandy loam
Paddock loam:
0 to 5 inches—black loam
5 to 14 inches—dark grayish brown and grayish brown, mottled sandy loam
14 to 19 inches—dark yellowish brown and brown, mottled sandy loam
19 to 41 inches—dark yellowish brown and light olive brown, mottled sandy loam
41 to 50 inches—yellowish brown, mottled sandy loam
50 to 60 inches—yellowish brown, calcareous sandy loam

Soil Properties and Qualities

Drainage class: Somewhat poorly drained
Permeability: Moderate in the upper part; moderately slow to very slow in the lower part
Available water capacity: Moderate
Organic matter content: Moderate or high
Surface runoff: Slow
Depth to the water table: 1 to 3 feet
Other characteristics: As much as 3 percent of the surface covered with stones in some areas; root-restricting layer between depths of 40 and 55 inches

Inclusions

Contrasting inclusions:
• The well drained Rockwood and Redeye soils in the higher areas and in the more sloping areas
• Very poorly drained soils in depressions
Similar inclusions:
• Soils that have more clay in the subsoil

Use and Management

Cropland:
• If the stony areas are used as cropland, rocks generally need to be removed (fig. 6).
• Grassed waterways or shallow ditches can be used to remove excess surface water and thus permit more timely fieldwork.
Pasture and forage:
• Overgrazing or grazing when the soil is wet results in compaction of the surface layer and excessive runoff and increases the hazard of water erosion.
• Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep pastures in good condition.
Woodland:
• Trees should be harvested when the soil is dry or frozen.
• The use of equipment is restricted during wet periods because the soil is soft and cannot support heavy equipment.
• Stones on the surface in some areas hinder the use of machinery for planting and harvesting.
• Seedlings grow best if competing vegetation is controlled by applying herbicides or is removed mechanically.

Interpretive Groups

Land capability classification: Paddock loam, very stony—VIs; Paddock loam—IIw
Woodland ordination symbol: Paddock loam, very stony—4X; Paddock loam—4W

834—Friendship-Meehan loamy sands

Composition

Friendship soil and similar inclusions—40 to 60 percent
Meehan soil and similar inclusions—25 to 45 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Friendship—convex areas; Meehan—plane and concave areas
Landform: Outwash plains
Slope: 0 to 3 percent
Shape of areas: Irregular
Size of areas: 5 to 160 acres

Typical Profile

Friendship:
0 to 8 inches—very dark grayish brown loamy sand
8 to 13 inches—dark grayish brown sand
13 to 41 inches—dark yellowish brown sand
41 to 46 inches—brown, mottled sand

Figure 6.—Stones in areas of Paddock loam, very stony, in the Paddock complex should be removed before the areas are farmed.

46 to 60 inches—dark grayish brown and light brownish gray, mottled sand

Meehan:

0 to 8 inches—black loamy sand
8 to 11 inches—dark grayish brown loamy sand
11 to 17 inches—dark yellowish brown, mottled sand
17 to 40 inches—strong brown, mottled sand
40 to 60 inches—light gray sand

Soil Properties and Qualities

Drainage class: Friendship—moderately well drained; Meehan—somewhat poorly drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Friendship—moderately low or low; Meehan—low to moderate
Surface runoff: Slow
Depth to the water table: Friendship—2.5 to 6.0 feet; Meehan—1 to 3 feet

Inclusions

Contrasting inclusions:

- The very poorly drained Leafriver soils in concave areas and shallow depressions
- The poorly drained Roscommon soils in concave areas and shallow depressions
- The excessively drained Menahga soils in the higher areas

Similar inclusions:

- Soils that have more gravel or clay in the profile
- Soils that have a surface layer of sand

Use and Management

Cropland:

- Crops that mature early are best suited because of the amount of moisture received early in the season.
- Irrigating to overcome droughtiness is not practical for most crops because of the rapid permeability.
- Stripcropping, growing green manure crops, planting field windbreaks, using conservation tillage systems that keep crop residue on the surface, and planting cover crops conserve moisture, help to control soil blowing, and maintain the organic matter content of the plow layer.

Pasture and forage:

- Overgrazing when the soil is wet results in compaction of the surface layer, increases the hazard of soil blowing, and reduces the quality of pastures.

• Proper stocking rates, applications of fertilizer, weed control, deferment of grazing during dry periods, and rotation grazing in summer help to keep the pastures in good condition.
Woodland:
• Adequate site preparation and control or removal of competing vegetation are needed to establish a new stand.
• Removal of the surface layer during site preparation reduces the fertility and moisture-holding capacity of the soil and thus can hinder the establishment of young seedlings.
• Leaving some trees as windbreaks during harvesting protects seedlings from desiccating winds.
• Standard planting and harvesting equipment can be used throughout the year except for a short period during spring thaw. The very poorly drained and poorly drained included areas are not suited to equipment use.
• Loose sand interferes with the traction of wheeled equipment.

Interpretive Groups

Land capability classification: Friendship—IVs; Meehan—IVw
Woodland ordination symbol: Friendship—7S; Meehan—6W

1010—Riverwash

Landscape position: Along the Crow Wing River and the lakes in the northern part of the county
Kind of material: Narrow sandbars, commonly 1 to 3 feet above the water level, that continually are shifted as the water flow is altered
Slope: Nearly level
Shape of areas: Elongated
Size of areas: 3 to 8 acres
Drainage class: Poorly drained
Permeability: Very rapid
Frequency of flooding: Frequent
Interpretive groups: Not assigned

1015—Psamments, nearly level

Description of areas: Cuts or fills from the construction of structures, such as roads and buildings, and recreation areas
Kind of material: Fills—variable, but commonly very poorly drained soils in depressions and on flood plains that consist of material from the lower part of nearby soils; cuts—soils that consist of material that is similar to that of the lower part of the adjacent soils
Slope: 0 to 12 percent
Shape of areas: Irregular
Size of areas: 3 to 15 acres
Use and management:
• Onsite investigation is needed to determine the potential and limitations of this unit for specific uses, including use as sites for buildings, roads, and septic tank absorption fields.
Interpretive groups: Not assigned

1030—Udorthents-Pits complex

Description of areas: Active or abandoned areas used as sand and gravel pits, some of which are covered with excavated soil material, stock piles of sand and gravel, waste material, and ponds
Shape of areas: Irregular
Size of areas: 5 to 80 acres
Inclusions: Borrow pits from which loamy material has been removed
Use and management:
• If reclaimed, areas of this unit are suited to many uses. Reclamation, however, generally requires extensive filling and grading.
• Revegetation by grasses and brush has occurred naturally in some areas.
• If topsoil is stockpiled, some areas are suited to agricultural uses.
• Some areas are suitable for disposal of refuse, and some areas can be used for commercial or industrial development.
• Wildlife habitat or recreational areas can be developed by revegetating areas near the ponds.
• Onsite investigation is needed to determine the potential and limitations of areas for specific uses.
Interpretive groups: Not assigned

1941—Evart loam, frequently flooded

Composition

Evart soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Broad flats, shallow depressions
Landform: Flood plains
Slope: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 5 to 40 acres

Typical Profile

0 to 10 inches—very dark grayish brown loam
10 to 60 inches—dark gray and very dark gray, mottled fine sand and loamy fine sand

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Moderate in the upper part; rapid in the lower part
Available water capacity: Low
Organic matter content: Moderate
Surface runoff: Very slow
Depth to the water table: 0 to 2 feet
Frequency of flooding: Frequent

Inclusions

Contrasting inclusions:
• The moderately well drained Friendship soils adjacent to streams in the higher areas
• The very poorly drained Markey and Seelyeville soils, which have a layer of organic material more than 16 inches thick
Similar inclusions:
• Soils that have a mucky surface layer
• Soils that are somewhat poorly drained
• Soils that have cobbles in the profile
• Soils that have a surface layer of sand, loamy sand, sandy loam, or clay loam

Use and Management

Woodland:
• The use of equipment is restricted during wet periods because the soil is soft and cannot support heavy equipment.
• Trees should be harvested when the ground is frozen.
• The seedling mortality rate can be reduced by planting trees that can tolerate wetness.
• Seedlings grow well if competing vegetation is controlled by applying herbicides or is removed mechanically.

Interpretive Groups

Land capability classification: VIIw
Woodland ordination symbol: 2W

1942—Forada mucky loam, depressional

Composition

Forada soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Swales, concave areas, drainageways
Landforms: Outwash plains, moraines
Slope: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 6 to 40 acres

Typical Profile

0 to 2 inches—very dark gray mucky loam
2 to 16 inches—black sandy loam
16 to 18 inches—dark gray and gray, mottled sandy loam
18 to 27 inches—yellowish brown, mottled loamy sand
27 to 60 inches—yellowish brown, mottled, calcareous gravelly coarse sand

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Moderate or moderately rapid in the upper part; rapid in the lower part
Available water capacity: Moderate
Organic matter content: Very high or high
Surface runoff: Very slow or ponded
Depth to the water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• The very poorly drained Cathro, Markey, and Seelyeville soils, which have a layer of organic material 16 inches thick or more and are in concave areas near the center of depressions
• The moderately well drained Duelm and Oylen soils in the higher areas
Similar inclusions:
• Soils that are poorly drained or somewhat poorly drained
• Soils that are thinner in the upper part

Use and Management

Pasture and forage:
• Installing a drainage system and seeding plants that can tolerate wetness improve pastures.
• Controlling brush and deferring grazing when the soil is wet and until the forage is at an optimum height help to keep the pastures in good condition.

Interpretive Groups

Land capability classification: VIw, undrained; IIIw, drained
Woodland ordination symbol: Not assigned

1943—Roscommon loamy sand

Composition

Roscommon soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and slightly concave areas of

broad flats and shallow depressions
Landform: Outwash plains
Slope: 0 to 2 percent
Shape of areas: Oblong, circular, or elongated
Size of areas: 4 to 60 acres

Typical Profile

0 to 7 inches—black loamy sand
7 to 16 inches—light brownish gray sand
16 to 60 inches—light brownish gray, grayish brown, olive gray, and gray, mottled sand

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: High
Surface runoff: Slow
Depth to the water table: 0 to 1 foot

Inclusions

Contrasting inclusions:
• The very poorly drained Markey and Seelyeville soils in concave areas near the center of depressions
• The excessively drained Menahga soils in slightly convex and plane areas on the higher parts of the landscape
• The moderately well drained Friendship soils in slightly convex and plane areas on the higher parts of the landscape
Similar inclusions:
• Soils that are redder in the lower part
• Soils that are somewhat poorly drained
• Soils that are loamy in the lower part
• Soils that have a surface layer of mucky loamy sand

Use and Management

Cropland:
• Drainage is restricted because most of the unit is in low-lying areas and locating suitable outlets is difficult.
• Soil blowing can be controlled by planting windbreaks and by using conservation tillage systems that keep crop residue on the surface.
• Using conservation tillage systems, planting cover crops, and returning crop residue to the soil help to maintain tilth and the content of organic matter.
Pasture and forage:
• The best suited species are those that can tolerate wetness.
• Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep pastures in good condition.
Woodland:
• Trees should be harvested during extended dry periods or in winter when the ground is frozen.
• Trees suitable for planting are those that can tolerate wetness.
• Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the windthrow hazard.

Interpretive Groups

Land capability classification: IVw
Woodland ordination symbol: 6W

1956—Staples loamy sand

Composition

Staples soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and slightly convex areas on foot slopes and in depressions
Landform: Glacial drumlins
Slope: 0 to 2 percent
Shape of areas: Elongated
Size of areas: 5 to 25 acres

Typical Profile

0 to 7 inches—very dark gray, mottled loamy sand
7 to 36 inches—very dark grayish brown and grayish brown, mottled sand
36 to 60 inches—olive gray, mottled sandy loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Rapid in the upper part; moderately slow to very slow in the lower part
Available water capacity: Low
Organic matter content: Moderate or high
Surface runoff: Slow
Depth to the water table: 0.5 foot to 2.0 feet
Other characteristics: Root-restricting layer at a depth of 44 inches

Inclusions

Contrasting inclusions:
• The moderately well drained Huntersville soils in the higher areas
• The well drained Redeye soils in the higher areas
• The very poorly drained Leafriver and Markey soils in concave areas near the center of depressions
• The somewhat poorly drained Meehan soils, which are not underlain by glacial till and are in the slightly higher areas
Similar inclusions:
• Soils that have a thin layer of muck
• Soils that are somewhat poorly drained

• Soils that are deeper to a root-restricting layer
• Soils that have a surface layer of loamy fine sand

Use and Management

Cropland:
• Open ditches can be used to remove excess water.
• Drainage is restricted because most of the unit is in low-lying areas and locating suitable outlets is difficult.
Pasture and forage:
• Grasses and legumes that can tolerate wetness are best suited.
• Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep pastures in good condition.
Woodland:
• Trees suitable for planting are those that can tolerate wetness.
• Wetness in spring can delay planting by machine.
• Trees should be harvested during extended dry periods or in winter when the ground is frozen.
• Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the windthrow hazard.

Interpretive Groups

Land capability classification: IIIw
Woodland ordination symbol: 6W

1957B—Friendship loamy sand, till substratum, 1 to 6 percent slopes

Composition

Friendship soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and convex areas
Landform: Outwash plains
Shape of areas: Elongated
Size of areas: 5 to 40 acres

Typical Profile

0 to 3 inches—very dark gray loamy sand
3 to 20 inches—dark brown and brown sand
20 to 44 inches—light yellowish brown and light brownish gray, mottled sand
44 to 60 inches—light brownish gray, light yellowish brown, and yellowish brown, mottled sandy loam stratified with loamy sand

Soil Properties and Qualities

Drainage class: Moderately well drained
Permeability: Rapid in the upper part; moderately slow or moderate in the lower part
Available water capacity: Low
Organic matter content: Moderately low or low
Surface runoff: Slow
Depth to the water table: 3 to 6 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Markey soils, which consist of organic material over mineral material and are in depressions and interdrumlin areas
• The excessively drained Menahga soils, which do not have glacial till within a depth of 6 feet
• The poorly drained Roscommon and Staples soils in concave and plane areas on the lower parts of the landscape
• The very poorly drained Runeberg soils in concave and plane areas on the lower parts of the landscape
Similar inclusions:
• Soils that have a mantle of sandy material less than 40 inches or more than 60 inches thick
• Soils that have more clay in the profile
• Soils that have a surface layer of sand

Use and Management

Cropland:
• Because of the limited available water capacity, most crops should be irrigated.
• The best suited crops are those that can tolerate droughtiness. The amount of moisture available is not adequate for good growth of other crops.
• Stripcropping, planting green manure crops, spreading manure, using conservation tillage systems that keep crop residue on the surface, and planting cover crops conserve moisture, help to control soil blowing, and maintain the organic matter content of the plow layer.
Pasture and forage:
• Overgrazing increases the hazard of soil blowing and reduces the quality of pastures.
• Proper stocking rates, deferment of grazing during dry periods, applications of fertilizer, weed control, and rotation grazing during summer help to keep the pastures in good condition.
Woodland:
• Logging roads should be constructed on the contour.
• The use of standard planting and logging equipment should be restricted during spring thaw and other wet periods.
• Timber should be harvested when the soil is dry or frozen.
• Adequate site preparation and control or removal of competing vegetation are needed to establish a new stand.
• Removal of the surface layer during site preparation reduces the fertility and moisture-holding capacity of the

soil and thus can limit the establishment of young seedlings.
• Leaving some trees as windbreaks during harvesting helps to protect seedlings from desiccating winds.

Interpretive Groups

Land capability classification: IIIs
Woodland ordination symbol: 6S

1968—Evart loam, occasionally flooded

Composition

Evart soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and slightly concave areas on broad flats and in shallow depressions
Landform: Flood plains
Slope: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 5 to 50 acres

Typical Profile

0 to 6 inches—very dark brown loam
6 to 11 inches—very dark brown, mottled loam
11 to 14 inches—dark grayish brown, mottled loamy very fine sand
14 to 18 inches—grayish brown, mottled fine sand
18 to 31 inches—light brownish gray and light gray, mottled sand
31 to 60 inches—light brownish gray, pinkish gray, and brown, mottled coarse sand

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Moderate in the upper part; rapid in the lower part
Available water capacity: Low
Organic matter content: Moderate
Surface runoff: Very slow
Depth to the water table: 0 to 2 feet
Frequency of flooding: Occasional

Inclusions

Contrasting inclusions:
• The moderately well drained Friendship soils adjacent to streams
• The very poorly drained Markey and Seelyeville soils, which have a layer of organic material more than 16 inches thick
Similar inclusions:
• Soils that have a mucky surface layer
• Soils that are somewhat poorly drained
• Soils that have cobbles in the profile
• Soils that have a surface layer of sand, loamy sand, sandy loam, or clay loam

Use and Management

Cropland:
• Drainage is restricted because most of the unit is in low-lying areas and locating suitable outlets is difficult.
• The seasonal flooding limits the production and harvesting of crops.
Pasture and forage:
• Grasses and legumes that can tolerate wetness are best suited.
• Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep pastures in good condition.
Woodland:
• The use of equipment is restricted during wet periods because the soil is soft and cannot support heavy equipment.
• Trees should be harvested when the ground is frozen.
• The seedling mortality rate can be reduced by planting trees that can tolerate wetness.
• Seedlings grow well if competing vegetation is controlled by applying herbicides or is removed mechanically.

Interpretive Groups

Land capability classification: IVw
Woodland ordination symbol: 7W

1969—Evart-Isan complex, channeled

Composition

Evart soil and similar inclusions—55 to 65 percent
Isan soil and similar inclusions—25 to 35 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Evart—concave areas on the lower parts of the landscape adjacent to streams; Isan—concave and convex areas on the higher parts of the landscape along foot slopes and adjacent to terrace escarpments
Landform: Evart—flood plains; Isan—outwash plains
Slope: 0 to 1 percent
Shape of areas: Elongated
Size of areas: 40 to 120 acres

Typical Profile

Evart:
0 to 13 inches—black and very dark gray loam
13 to 24 inches—dark gray, mottled, stratified loam and fine sand

24 to 31 inches—yellowish red, mottled sand
31 to 60 inches—gray sand
Isan:
0 to 13 inches—black sandy loam
13 to 27 inches—gray, mottled sand
27 to 60 inches—gray, mottled sand and coarse sand

Soil Properties and Qualities

Drainage class: Evart—very poorly drained or poorly drained; Isan—poorly drained
Permeability: Evart—moderate in the upper part, rapid in the lower part; Isan—rapid
Available water capacity: Evart—moderate; Isan—low
Organic matter content: Evart—moderate; Isan—moderate or high
Surface runoff: Slow
Depth to the water table: Evart—0 to 2 feet below the surface; Isan—0.5 foot to 2.0 feet
Frequency of flooding: Evart—frequent; Isan—none

Inclusions

Contrasting inclusions:
• The moderately well drained Friendship soils in plane and convex areas adjacent to flood plains
• The moderately well drained Oylen soils in plane and convex areas on the higher parts of the landscape adjacent to flood plains
• The excessively drained Menahga soils in the higher areas
Similar inclusions:
• Soils that have a mucky surface layer
• Soils that are somewhat poorly drained
• Soils that have cobbles in the profile
• Soils that have a surface layer of loamy sand or clay loam

Use and Management

Cropland:
• Installing drainage systems in most areas of this unit is impractical.
• The meandering rivers and streams in this unit restrict management of individual parcels of land and limit accessibility by equipment.
Pasture and forage:
• Grasses and legumes that can tolerate wetness are best suited.
• Because of the limited accessibility and the small size of the individual areas, improving pastures is difficult.
• Restricting grazing reduces the hazard of streambank erosion at water crossings.
• Animal waste should be kept from entering the rivers and streams and polluting the water.
• Fences can keep livestock away from streambanks and out of the watercourses, thus reducing the hazards of streambank erosion and water contamination.
Woodland:
• The use of equipment is restricted during wet periods because the soil is soft and cannot support heavy equipment.
• Trees should be harvested when the ground is frozen.
• The seedling mortality rate can be reduced by planting trees that can tolerate wetness.
• Seedlings grow well if competing vegetation is controlled by applying herbicides or is removed mechanically.

Interpretive Groups

Land capability classification: Evart—VIIw; Isan—IVw
Woodland ordination symbol: Evart—7W; Isan—not assigned

1970B—Menahga loamy sand, till substratum, 1 to 8 percent slopes

Composition

Menahga soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and convex areas
Landform: Outwash plains
Shape of areas: Elongated
Size of areas: 5 to 20 acres

Typical Profile

0 to 4 inches—black loamy sand
4 to 8 inches—dark brown sand
8 to 31 inches—brown sand
31 to 55 inches—yellowish brown and light yellowish brown sand
55 to 60 inches—dark yellowish brown, light yellowish brown, and yellowish brown loamy sand and sandy loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Rapid in the upper part; slow or moderately slow in the lower part
Available water capacity: Low
Organic matter content: Moderately low or low
Surface runoff: Slow
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The well drained Rockwood soils, which do not have a

mantle of sandy material over till
• The poorly drained Roscommon and Staples soils in concave areas and in the lower areas
Similar inclusions:
• Soils that are sandy to a depth of less than 40 inches or more than 60 inches
• Soils that are moderately well drained or somewhat poorly drained
• Soils that have more clay in the profile

Use and Management

Cropland:
• Because of the limited available water capacity, most crops should be irrigated.
• The best suited crops are those that can tolerate droughtiness. The amount of moisture available is not adequate for good growth of other crops.
• Stripcropping, planting green manure crops, spreading manure, using conservation tillage systems that keep crop residue on the surface, and planting cover crops conserve moisture, help to control soil blowing, and maintain the organic matter content of the plow layer.
Pasture and forage:
• Overgrazing increases the hazard of soil blowing and reduces the quality of pastures.
• Proper stocking rates, deferment of grazing until plants reach a minimum height, applications of fertilizer, weed control, and rotation grazing during summer help to keep the pastures in good condition.
Woodland:
• The seedling survival rate can be improved by carefully planting vigorous nursery stock.
• Trees suitable for planting are those that can tolerate droughtiness.
• Removing the surface layer during site preparation reduces the fertility and moisture-holding capacity of the soil.

Interpretive Groups

Land capability classification: IVs
Woodland ordination symbol: 6S

1975—Oylen sandy loam

Composition

Oylen soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane, slightly convex, and concave areas
Landform: Outwash plains
Shape of areas: Irregular
Size of areas: 5 to 60 acres

Typical Profile

0 to 10 inches—black sandy loam
10 to 18 inches—dark yellowish brown sandy loam
18 to 24 inches—dark yellowish brown coarse sand
24 to 38 inches—yellowish brown, mottled sand
38 to 60 inches—light brownish gray, mottled, calcareous gravelly coarse sand

Soil Properties and Qualities

Drainage class: Moderately well drained
Permeability: Moderately rapid or rapid in the upper part; rapid in the lower part
Available water capacity: Low
Organic matter content: Moderate
Surface runoff: Slow
Depth to the water table: 2 to 5 feet

Inclusions

Contrasting inclusions:
• The poorly drained and very poorly drained Forada soils in concave areas and depressions on the slightly lower parts of the landscape
• The poorly drained Isan soils in concave areas and depressions on the slightly lower parts of the landscape
Similar inclusions:
• Soils that are well drained or somewhat poorly drained
• Soils that have more clay in the profile

Use and Management

Cropland:
• Using conservation tillage systems that keep crop residue on the surface and growing cover crops conserve moisture, help to control soil blowing, and maintain the organic matter content of the plow layer.
• Irrigation may be needed to overcome droughtiness if costly specialty crops are grown.
Pasture and forage:
• Overgrazing increases the runoff rate and reduces the quality of pastures.
• Proper stocking rates, deferment of grazing during wet periods, applications of fertilizer, weed control, and rotation grazing in summer help to keep the pastures in good condition.

Interpretive Groups

Land capability classification: IIIs
Woodland ordination symbol: Not assigned

1984—Leafriver muck

Composition

Leafriver soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and concave areas, depressions
Landform: Outwash plains
Slope: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 5 to 40 acres

Typical Profile

0 to 9 inches—black muck
9 to 14 inches—black sandy loam
14 to 60 inches—dark grayish brown and grayish brown, mottled loamy sand

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Moderately rapid or moderate in the upper part; rapid in the lower part
Available water capacity: Moderate
Organic matter content: Very high
Surface runoff: Very slow or ponded
Depth to the water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• The very poorly drained Cathro, Markey, Rifle, and Seelyeville soils, which have a layer of organic material more than 16 inches thick and generally are near the center of depressions
• The moderately well drained Duelm, Friendship, and Oylen soils in the adjacent higher areas
Similar inclusions:
• Soils that have a thinner layer of muck or do not have a layer of muck
• Soils that are poorly drained or somewhat poorly drained
• Soils that have a thin layer of loamy material in the lower part
• Soils that have a surface layer of mucky peat or peat
• Soils that have more clay in the substratum

Use and Management

Pasture and forage:
• Installing a drainage system and seeding plants that can tolerate wetness improve pastures.
• Controlling brush and deferring grazing when the soil is wet and until the forage is at an optimum height help to keep the pastures in good condition.

Interpretive Groups

Land capability classification: VIw, undrained; IVw, drained
Woodland ordination symbol: Not assigned

1985—Fordum silt loam, occasionally flooded

Composition

Fordum soil and similar inclusions—85 to 95 percent
Contrasting inclusions—5 to 15 percent

Setting

Landscape position: Plane and concave areas
Landform: Flood plains
Slope: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 5 to 50 acres

Typical Profile

0 to 8 inches—black silt loam
8 to 20 inches—stratified very dark grayish brown and dark grayish brown, mottled silt loam
20 to 22 inches—dark grayish brown, mottled loamy fine sand
22 to 28 inches—dark grayish brown, mottled loam
28 to 35 inches—dark grayish brown, mottled silt loam
35 to 60 inches—light olive gray and yellowish brown, mottled, stratified fine sand, sand, and loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Moderate or moderately rapid in the upper part; moderately rapid in the lower part
Available water capacity: Moderate
Organic matter content: High or very high
Surface runoff: Slow
Depth to the water table: 0 to 1 foot
Frequency of flooding: Occasional

Inclusions

Contrasting inclusions:
• The very poorly drained Cathro and Markey soils, which have a layer of organic material 16 to 51 inches thick
• The moderately well drained Friendship soils, which are sandy throughout and are not subject to flooding
• The somewhat poorly drained Meehan soils, which are sandy throughout and are not subject to flooding
Similar inclusions:
• Soils that are rarely flooded or are not flooded
• Soils that are sandy in the lower part
• Soils that are very poorly drained and are frequently flooded
• Soils that have a surface layer of loam, sandy loam, fine sand, mucky loam, mucky sandy loam, or mucky fine sand

Use and Management

Cropland:
• Drainage is restricted because most of the unit is in low-lying areas and locating suitable outlets is difficult.
• The seasonal flooding limits the production and harvesting of crops.
Pasture and forage:
• Grasses and legumes that can tolerate wetness are best suited.
• Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep pastures in good condition.
• Fences can keep livestock away from streambanks and out of the watercourses, thus reducing the hazards of streambank erosion and water contamination.
Woodland:
• The use of equipment is restricted during wet periods because the soil is soft and cannot support heavy equipment.
• Trees should be harvested when the ground is frozen.
• The seedling mortality rate can be reduced by planting trees that can tolerate wetness.
• Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the windthrow hazard.

Interpretive Groups

Land capability classification: IVw
Woodland ordination symbol: 6W

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal expenditure of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 75,910 acres in the survey area, or nearly 22 percent of the total acreage, meets the soil requirements for prime farmland. The main crops grown on this land are corn, oats, and barley.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Forada loam is limited by a seasonal high water table, and it qualifies for prime farmland only in areas where this limitation has been overcome by drainage measures. Onsite evaluation is needed to determine whether or not the limitation has been overcome by corrective measures.

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Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations of natural resources and the environment. Also, it can help to avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where wetness or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

With proper management, many crops and pasture plants can be grown in Wadena County. The dominant crops are corn, hay, and oats. Small acreages of edible beans, soybeans, sunflowers, wheat, barley, and buckwheat also are grown.

The hazards of soil blowing and water erosion are major concerns in the county. Water erosion is most critical in the sloping and gently sloping areas within the glacial drumlins. Conserving the topsoil is important because it acts as a site for storage of nutrients and water for use by plants. Conservation practices restrict the surface runoff of farm chemicals, reduce nutrient losses, and limit sedimentation caused by water erosion or soil blowing.

Conservation tillage practices, such as no-till or minimum tillage, protect the soil surface from soil blowing and water erosion (fig. 7). Protecting the topsoil with plant residue reduces soil crusting, slows runoff, and increases the infiltration rate. Other conservation practices that are helpful include stripcropping (fig. 8), planting on the contour, field windbreaks, grassed waterways, and permanent sod.

Some fields in the glacial drumlin areas have rock fragments on the surface. These rock fragments interfere with farm equipment operations. Some very stony areas are used for permanent pasture.

The glacial outwash areas in the county are susceptible to soil blowing. Field windbreaks and conservation tillage practices reduce the hazard of soil blowing. Most of the soils in these areas are droughty, and many are suited to irrigation. The coarser textured soils that are rapidly permeable require greater amounts of irrigation water. Irrigation water is available in most areas. In some areas windbreaks have been removed to accommodate irrigation equipment. In these areas it

Figure 7.—Conservation tillage systems that leave crop residue on the surface help to control erosion.

is important to protect the topsoil with crop residue during the critical erosion period. Leaving crop residue on the surface also limits moisture loss by reducing the evaporation rate.

A drainage system is needed on some soils in both the drumlin and the outwash areas. Concerns associated with installing a drainage system are cost, availability of drainage outlets, subsidence of peat soils, and maintenance of the drainage system. Locating suitable drainage outlets is difficult because most of the wet soils are in low-lying areas. A system of ditches was constructed by the county and private landowners, but many of the ditches have not been maintained adequately.

The poorly drained areas are best suited to growing forage crops, such as grass-legume mixtures of reed canarygrass, timothy, alsike clover, or birdsfoot trefoil. Wild meadow hay is harvested in many areas. If the organic soils are adequately drained, they can be used for the production of bluegrass seed, sod, or other specialty crops. Peat from areas of organic soils can be harvested for horticultural uses and potentially as a source of energy.

Many areas in the county are used for pasture. Pastures can be improved with proper management. The different soil types determine the type of management needed. Suitable management practices include maintaining proper nutrient levels, using suitable forage plants, rotating pastures, and maintaining proper stocking rates. The use of wet pastures should be deferred until the sod is firm, the forage has reached a minimum height, and the plants are growing vigorously. Overgrazing reduces the quality of pastures and the ability of the plants to recover after grazing. Interseeding the pastures with legume-grass combinations, such as clover and reed canarygrass, can increase the feed value and yield of forage. Improvement of pastures in areas that have many cobbles and boulders on the surface may be difficult.

Most of the soils in the county have a moderate to high content of available phosphorus and a low content of available potassium. The coarser textured soils commonly are deficient in sulfur content. Some crops respond to additions of boron and magnesium. The ability of plants to use the nutrients is affected by soil reaction (pH). Lime can be used to increase reaction to

the desired level. Alfalfa, for example, is very sensitive to proper soil reaction. Soil tests are needed to determine the fertility and reaction of the soil. Soil testing can be done by private agricultural businesses or with the help of the County Extension Office and the University of Minnesota. The kinds and amounts of fertilizer needed also depend on the level of management desired by the operator.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in

Figure 8.—Stripcropping on the contour helps to control water erosion on long slopes.

the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and engineering purposes.

In the capability system *(17)*, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e*, *w*, or *s*, to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); and *s* shows that the soil is limited mainly because it is shallow, droughty, or stony.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w* or *s* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in table 6.

Woodland Management and Productivity

Woodland management should be based on the types of wood products desired. Tree selection should be based on the suitability of the soil, the growing conditions, and the intended use. The woodland site indexes and yield data are useful in evaluating sites for growing and managing various trees.

Site preparation is important in establishing a stand of desirable trees. Operations that are important in site preparation include treating slash to reduce the risk of fire, reducing competition from shrubs and undesirable trees, and preparing a favorable seedbed. The most reliable method for starting a red pine (Norway pine) stand is to plant nursery-grown seedlings in spring *(5)*. Direct seeding of repellent-treated seed generally is a successful method for establishing jack pine *(4)*. The use of containerized seedlings is very successful for some trees. Disturbing the topsoil can reduce the fertility of the soil and damage parent roots of plants, which is a concern particularly in producing quaking aspen from suckers *(14)*. If aspen is clearcut, an adequate population of young trees generally is produced by regeneration. Regeneration is most successful if harvesting is done in winter. If an area is to be converted from aspen to red pine, the aspen must be controlled by herbicides or removed mechanically. Maintaining a shelterbelt helps to protect seedlings from desiccating winds.

Proper management of a stand of trees requires controlling the growth and composition of that stand. Suitable practices include replanting, weeding, thinning, pruning, and establishing a harvesting rotation.

Access roads should be provided to facilitate fire protection, thinning, and other operations included in the management program. Roads should be constructed in such a way that water erosion and compaction are minimized.

Clearcutting and selective cutting are two basic

harvesting systems. Clearcutting involves harvesting all of the mature trees in a stand, and selective cutting involves harvesting only certain trees in a stand. Selective cutting can be used in areas where such trees as quaking aspen, white spruce, and balsam fir are grown concurrently and it is desirable to harvest only white spruce or aspen.

Harvesting should take place according to an established rotation. Windthrow can be a hazard on soils that have a restricted rooting depth. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the windthrow hazard. Logging roads should be constructed in such a way that erosion is minimized and the soil surface is protected after harvesting. When harvesting near lakes and streams, care should be taken to prevent soil and debris from entering the watercourses.

Harvesting timber when the ground is frozen reduces the risk of water erosion and facilitates equipment use on the wetter soils. Most logging operations are hampered during the period of snowmelt in spring because the soil is saturated above the frost line. The snowmelt period usually is from March through May. Its length and severity vary, depending on the climatic conditions and soil types.

Additional information concerning woodland management can be obtained from the Minnesota Department of Natural Resources, local offices of the Soil Conservation Service, and private forestry managers.

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for an indicator tree species. The number indicates the volume, in cubic meters per hectare per year, which the indicator species can produce. The number 1 indicates low potential productivity; 2 and 3, moderate; 4 and 5, moderately high; 6 to 8, high; 9 to 11, very high; and 12 to 39, extremely high. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *R* indicates steep slopes; *X*, stoniness or rockiness; *W*, excess water in or on the soil; *T*, toxic substances in the soil; *D*, restricted rooting depth; *C*, clay in the upper part of the soil; *S*, sandy texture; *F*, a high content of rock fragments in the soil; and *L*, low strength. The letter *A* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, T, D, C, S, F, and L.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Erosion hazard is the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, fire lanes, and log-handling areas. Forests that have been burned or overgrazed are also subject to erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

Equipment limitation reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of *slight* indicates that under normal conditions the kind of equipment or season of use is not significantly restricted by soil factors. Soil wetness can restrict equipment use, but the wet period does not exceed 1 month. A rating of *moderate* indicates that equipment use is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts equipment use for a period of 1 to 3 months. A rating of *severe* indicates that equipment use is severely restricted either as to the kind of equipment that can be used or the season of use. If the soil is wet, the wetness restricts equipment use for more than 3 months.

Seedling mortality refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, soil wetness, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, and slope aspect. A rating of *slight* indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of *moderate* indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent. A rating of *severe* indicates that seedling mortality is a serious problem. Extra precautions are important. Replanting may be

necessary. Expected mortality is more than 50 percent.

Windthrow hazard is the likelihood that trees will be uprooted by the wind because the soil is not deep enough for adequate root anchorage. The main restrictions that affect rooting are a seasonal high water table and the depth to bedrock, a fragipan, or other limiting layers. A rating of *slight* indicates that under normal conditions no trees are blown down by the wind. Strong winds may damage trees, but they do not uproot them. A rating of *moderate* indicates that some trees can be blown down during periods when the soil is wet and winds are moderate or strong. A rating of *severe* indicates that many trees can be blown down during these periods.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* and as a *volume* number. The site index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

The *volume*, a number, is the yield likely to be produced by the most important trees. This number, expressed as cubic feet per acre per year, indicates the amount of fiber produced in a fully stocked, even-aged, unmanaged stand.

The first species listed under *common trees* for a soil is the indicator species for that soil. It is the most important wood-producing species on the soil and the one that determines the ordination class.

Trees to plant are those that are suitable for commercial wood production.

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow (fig. 9). They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Wadena County offers a variety of recreational opportunities. Camping, canoeing, boating, hunting, fishing, horseback riding, snowmobiling, and nature studying are most common. The major recreational areas are the Crow Wing River Canoe Trail; the county parks of Cottingham, McGivern, and Old Wadena; the state forest land in Huntersville and Lyons Townships; and the lake region in the northwestern part of the county. Numerous campsites have been developed along the Crow Wing River. Shell City, Tree Farm Landing, Anderson Crossing, Indian Mound, Little White Dog, and Old Wadena are historical camp areas. The cities of Wadena, Verndale, Sebeka, and Menahga provide community parks and picnic areas.

The Crow Wing Wilderness Saddle and Snowmobile Trail is about 31 miles long. The Huntersville Water Impoundments area has been developed as habitat for wildlife and is open to public hunting. Fishing is provided by lakes in the northwestern part of the county and by the rivers in the county. Two golf courses are in the county; one is north of Wadena, and the other is north of Staples. More information on the potential for outdoor recreational developments can be obtained from the Wadena County Soil and Water Conservation District or the local Chamber of Commerce or tourism centers.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also

Figure 9.—Farmstead windbreaks in an area of Duelm loamy sand.

important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils are gently sloping and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping

sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Several hundred acres of shallow and deep freshwater marshes and wetlands are in the county. These areas provide habitat for furbearers, such as muskrat, mink, and beaver.

Public fishing is provided by Spirit, Stocking, Blueberry, Lower Twin, and Duck Lakes. The Crow Wing, Leaf, and Shell Rivers and numerous other small streams and rivers also provide fishing. The fish in these areas include northern pike, bass, walleye, and panfish. Some coldwater streams support trout or have the potential to provide habitat for trout. Some of the shallower lakes are subject to occasional winterkill.

The marshes, wetlands, and bodies of water in the county also provide habitat for waterfowl.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 10, the soils in the survey area are rated according to their potential for providing specific elements of wildlife habitat. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining the habitat elements; and in determining the intensity of management needed for each habitat element.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element. The element can be established, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element are very severe and that unsatisfactory results can be expected. Establishing, improving, or maintaining the element is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn and oats.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, and beggarweed.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak and poplar. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian olive, autumn olive, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, and tamarack.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kinds of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a

maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or to a very firm dense layer, stone content, soil texture, and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Revegetating construction sites can be a problem. Stockpiling the upper part of the soil and applying mulch help to establish vegetation.

Installing tile lines around foundations helps to remove excess surface water. In areas that have a seasonal high water table, a sump pump also may be needed.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation. Soils that have a high water table do not readily absorb effluent and have a poor filtering capacity, which can result in pollution of shallow ground water. Nitrates, chloride, and calcium are stratified in the ground water. Generally, higher concentrations of these compounds are in the upper part of the aquifer *(1)*.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent

effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, flooding, large stones, and content of organic matter.

Excessive seepage resulting from rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, and soil reaction affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable

material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. These soils may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features generally are favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even more than the height of the embankment

can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders or organic matter. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by large stones, slope, and the hazard of cutbanks caving. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a dense layer. The performance of a system is affected by the depth of the root zone and by soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to control erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a dense layer affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a dense layer affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

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Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

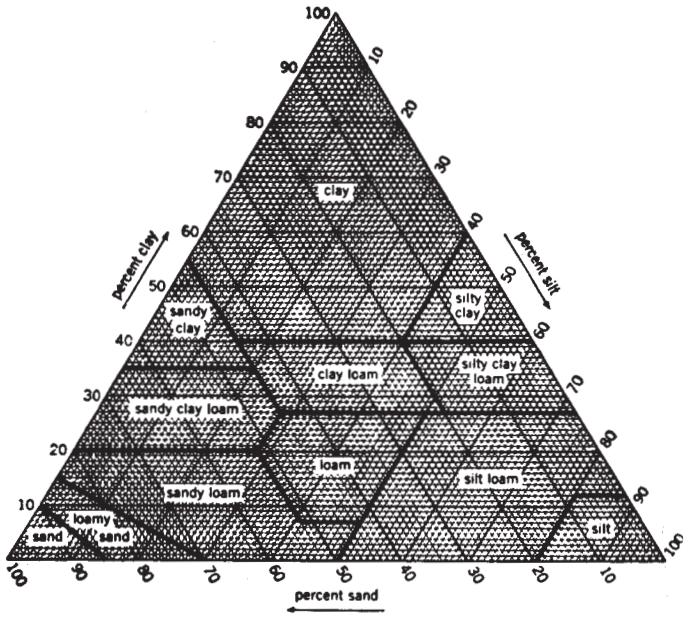

Figure 10.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each taxonomic unit under "Taxonomic Units and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 10). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(3)* and the system adopted by the American Association of State Highway and Transportation Officials *(2)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at ⅓ bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Coarse sands, sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.
3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.
5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.
6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control wind erosion are used.
7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control wind erosion are used.
8. Soils that are not subject to wind erosion because of coarse fragments on the surface or because of surface wetness.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist

mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 17, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 17 shows the total subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

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Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(19)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Entisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquent (*Aqu*, meaning water, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Psammaquents (*Psamm*, meaning sandy, plus *aquent*, the suborder of the Entisols that has an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Mollic* identifies the subgroup that is dark. An example is Mollic Psammaquents.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is mixed, frigid Mollic Psammaquents.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Taxonomic Units and Their Morphology

In this section, each taxonomic unit recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each unit. A pedon, a small three-dimensional area of soil, that is typical of the unit in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (16)*. Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (19)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the units.

The map units of each taxonomic unit are described in the section "Detailed Soil Map Units."

Blowers Series

Drainage class: Moderately well drained
Permeability: Moderate in the upper part; moderately slow to very slow in the lower part

Landform: Drumlins
Parent material: Glacial till
Slope: 1 to 5 percent

Taxonomic class: Coarse-loamy, mixed Aquic Eutroboralfs

Typical Pedon

Blowers sandy loam, 1 to 5 percent slopes; 2,050 feet west and 600 feet north of the southeast corner of sec. 6, T. 136 N., R. 34 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

E—9 to 20 inches; brown (10YR 5/3) sandy loam, very pale brown (10YR 7/3) dry; weak fine subangular blocky structure; very friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

E/B—20 to 25 inches; 60 percent grayish brown (10YR 5/2) sandy loam (E) and 40 percent dark yellowish brown (10YR 4/4) sandy loam (Bt); weak fine subangular blocky structure; very friable; about 5 percent coarse fragments; slightly acid; clear smooth boundary.

Bt1—25 to 32 inches; yellowish brown (10YR 5/4) sandy clay loam; many coarse distinct light brownish gray (2.5Y 6/2) and grayish brown (2.5Y 5/2) and common medium distinct brownish yellow (10YR 6/8) mottles; moderate medium subangular blocky structure; friable; many prominent dark brown (10YR 3/3) clay films on faces of peds and in pores; about 5 percent coarse fragments; slightly acid; clear smooth boundary.

Bt2—32 to 49 inches; olive brown (2.5Y 4/4) sandy loam; few fine distinct grayish brown (2.5Y 5/2) and olive gray (5Y 5/2) and common medium distinct dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; firm; few distinct dark brown (10YR 3/3) clay films on faces of peds; about 5 percent coarse fragments; neutral; clear smooth boundary.

Cd—49 to 60 inches; light olive brown (2.5Y 5/4) sandy loam; common medium distinct gray (5Y 6/1) and olive gray (5Y 5/2) mottles; weak thick platy fragments; very firm; about 5 percent coarse fragments; neutral.

Range in Characteristics

Depth to carbonates: 40 to 70 inches
Content of rock fragments: 0 to 15 percent gravel and cobbles

Ap horizon:
Hue—10YR or 2.5Y
Value—2 or 3
Chroma—1 to 3
Texture—sandy loam

E horizon:
Hue—10YR or 2.5Y
Value—4 or 5
Chroma—2 or 3
Texture—sandy loam or loamy sand

E/B horizon:
Colors and textures—similar to those of the E and Bt horizons

Bt horizon:
Hue—10YR or 2.5Y
Value—4 or 5
Chroma—3 to 5
Texture—sandy loam or sandy clay loam

Cd horizon:
Hue—10YR or 2.5Y
Value—5 or 6
Chroma—4 or 5
Texture—sandy loam or loamy sand

Cathro Series

Drainage class: Very poorly drained
Permeability: Moderately rapid to moderately slow in the upper part; moderate or moderately slow in the lower part
Landforms: Outwash plains, ground moraines
Parent material: Moderately thick, highly decomposed herbaceous plant material over mineral material
Slope: 0 to 2 percent

Taxonomic class: Loamy, mixed, euic Terric Borosaprists

Typical Pedon

Cathro muck; 250 feet south and 2,450 feet east of the northwest corner of sec. 9, T. 135 N., R. 35 W.

Oa—0 to 26 inches; black (10YR 2/1, rubbed) muck; about 30 percent fibers unrubbed and 5 percent rubbed; very friable; dominantly herbaceous fibers, few woody fragments; slightly acid; abrupt smooth boundary.

Ab—26 to 35 inches; black (10YR 2/1) mucky loam; massive; firm, slightly sticky; neutral; clear smooth boundary.

Cg1—35 to 38 inches; dark gray (5Y 4/1) loam; massive; firm; neutral; clear smooth boundary.

Cg2—38 to 60 inches; olive gray (5Y 5/2) sandy loam; common medium prominent strong brown (7.5YR 5/6) and common medium distinct light olive brown (2.5Y 5/4) mottles; massive; firm; neutral.

Range in Characteristics

Oa horizon:
Hue—10YR, 7.5YR, 5YR, or neutral
Value—2 or 3
Chroma—0 to 2
Thickness—16 to 50 inches
Kind of material—sapric
Content of fibers—20 to 50 percent unrubbed; 0 to 10 percent rubbed

Ab horizon (when present):
Hue—10YR
Value—2 or 3
Chroma—1
Texture—mucky loam

Cg horizon:
Hue—7.5YR to 5BG
Value—4 to 6
Chroma—1 or 2
Texture—loam, sandy loam, clay loam, or sandy clay loam

Dorset Series

Drainage class: Well drained
Permeability: Moderately rapid in the upper part; rapid in the lower part
Landform: Outwash plains
Parent material: Thin mantle of glacial alluvium over outwash sediment
Slope: 1 to 6 percent
Taxonomic class: Coarse-loamy, mixed Boralfic Udic Argiborolls

Typical Pedon

Dorset sandy loam, 1 to 3 percent slopes; 2,480 feet south and 550 feet east of the northwest corner of sec. 28, T. 134 N., R. 35 W.

Ap—0 to 9 inches; black (10YR 2/1) sandy loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; very friable; neutral; abrupt smooth boundary.
Bt1—9 to 16 inches; dark yellowish brown (10YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; common faint dark brown (10YR 4/3) clay films in pores and on faces of peds; neutral; abrupt smooth boundary.
2Bt2—16 to 21 inches; dark yellowish brown (10YR 4/4) gravelly loamy sand; weak fine subangular blocky structure; very friable; clay bridging sand grains; about 18 percent coarse fragments; neutral; clear smooth boundary.
2BC—21 to 30 inches; dark yellowish brown (10YR 4/4) gravelly sand; single grain; loose; about 25 percent coarse fragments; neutral; clear wavy boundary.
2C—30 to 60 inches; pale brown (10YR 6/3) gravelly coarse sand; single grain; loose; about 25 percent coarse fragments; slightly effervescent; mildly alkaline.

Range in Characteristics

Depth to carbonates: 24 to 36 inches
Thickness of the mollic epipedon: 7 to 11 inches

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—sandy loam
Content of rock fragments—0 to 10 percent gravel

Bt1 horizon:
Hue—10YR or 7.5YR
Value—3 to 5
Chroma—3 or 4
Texture—sandy loam or loam
Content of rock fragments—0 to 15 percent gravel

2Bt2 horizon:
Hue—10YR or 7.5YR
Value—3 to 5
Chroma—3 to 5
Texture—gravelly loamy coarse sand or gravelly loamy sand
Content of rock fragments—15 to 35 percent gravel

2C horizon:
Hue—10YR or 7.5YR
Value—3 to 6
Chroma—3 or 4
Texture—gravelly coarse sand or gravelly sand
Content of rock fragments—25 to 35 percent gravel

The Dorset soils in this county do not have the tongues or fingers of albic material in the upper part of the argillic horizon that are typical for the series. This difference, however, does not alter the usefulness or behavior of the soils.

Duelm Series

Drainage class: Moderately well drained
Permeability: Rapid
Landform: Outwash plains

Parent material: Glacial outwash
Slope: 0 to 2 percent

Taxonomic class: Sandy, mixed Aquic Haploborolls

Typical Pedon

Duelm loamy sand; 1,100 feet south and 75 feet west of the northeast corner of sec. 29, T. 135 N., R. 34 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) loamy sand, very dark grayish brown (10YR 3/2) dry; weak very fine subangular blocky structure; very friable; neutral; abrupt smooth boundary.

A—9 to 12 inches; very dark grayish brown (10YR 3/2) loamy sand, dark brown (10YR 3/3) dry; weak very fine subangular blocky structure; very friable; neutral; clear smooth boundary.

Bw1—12 to 24 inches; dark yellowish brown (10YR 3/4) sand; single grain; loose; slightly acid; clear smooth boundary.

Bw2—24 to 29 inches; dark yellowish brown (10YR 4/4) sand; few fine faint dark grayish brown (10YR 4/2) mottles; single grain; loose; slightly acid; clear smooth boundary.

Bw3—29 to 36 inches; dark yellowish brown (10YR 3/4) and dark brown (10YR 3/3) sand; common medium faint dark grayish brown (10YR 4/2) and brown (10YR 5/3) mottles; single grain; loose; about 2 percent gravel; neutral; clear smooth boundary.

C1—36 to 46 inches; dark grayish brown (10YR 4/2) sand; few fine faint very dark grayish brown (10YR 3/2) and dark brown (10YR 4/3) and few fine distinct light brownish gray (10YR 6/2) mottles; single grain; loose; many coarse distinct dark brown (7.5YR 3/2) and dark reddish brown (5YR 3/3) iron stains; about 4 percent gravel; neutral; clear smooth boundary.

C2—46 to 60 inches; light brownish gray (2.5Y 6/2) sand; single grain; loose; many coarse and medium prominent yellowish brown (10YR 5/6), brown (7.5YR 4/4), and strong brown (7.5YR 4/6) iron stains; slightly acid.

Range in Characteristics

Thickness of the mollic epipedon: 10 to 20 inches
Content of rock fragments: 0 to 5 percent gravel

Ap and A horizons:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loamy sand

Bw horizon:
Hue—10YR
Value—3 to 5
Chroma—2 to 4
Texture—coarse sand, sand, loamy sand, or loamy coarse sand

C horizon:
Hue—10YR or 2.5Y
Value—4 to 6
Chroma—1 to 4
Texture—coarse sand or sand

Evart Series

Drainage class: Poorly drained and very poorly drained
Permeability: Moderate in the upper part; rapid in the lower part
Landform: Flood plains
Parent material: Alluvium
Slope: 0 to 1 percent

Taxonomic class: Sandy, mixed, frigid Fluvaquentic Haplaquolls

Typical Pedon

Evart loam, occasionally flooded; 1,250 feet north and 2,525 feet east of the southwest corner of sec. 2, T. 135 N., R. 33 W.

Ap—0 to 6 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak very thin platy structure; very friable; neutral; abrupt smooth boundary.

A—6 to 11 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; few medium distinct brown (10YR 5/3) mottles; weak very thin platy structure; very friable; few dark grayish brown (10YR 4/2) discontinuous strata; neutral; abrupt smooth boundary.

Cg1—11 to 14 inches; dark grayish brown (2.5Y 4/2) loamy very fine sand, grayish brown (10YR 5/2) dry; common medium distinct dark gray (10YR 4/1) and few medium distinct brown (10YR 5/3) mottles; weak very thin platy structure; very friable; neutral; abrupt smooth boundary.

Cg2—14 to 18 inches; grayish brown (2.5Y 5/2) fine sand; common medium and coarse distinct yellowish brown (10YR 5/6) and few medium faint light brownish gray (2.5Y 6/2) mottles; massive; very friable; neutral; clear smooth boundary.

Cg3—18 to 31 inches; light brownish gray (2.5Y 6/2) and light gray (10YR 7/2) sand; common medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose; neutral; clear smooth boundary.

Cg4—31 to 42 inches; light brownish gray (2.5Y 6/2) coarse sand; common coarse distinct yellowish brown (10YR 5/4) mottles; single grain; loose; neutral; clear smooth boundary.

Cg5—42 to 60 inches; pinkish gray (7.5YR 6/2) and brown (7.5YR 4/4) coarse sand; common coarse distinct light brownish gray (2.5Y 6/2) mottles; single grain; loose; neutral.

Range in Characteristics

Thickness of the mollic epipedon: 10 to 20 inches

Ap and A horizons:
Hue—7.5YR or 10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam
Content of rock fragments—0 to 2 percent gravel

Cg horizon:
Hue—7.5YR, 10YR, 2.5Y, or 5Y
Value—4 to 6
Chroma—2 to 4
Texture—sand, coarse sand, loamy sand, or loamy coarse sand with occasional thin loamy strata
Content of rock fragments—0 to 10 percent gravel

Forada Series

Drainage class: Poorly drained and very poorly drained
Permeability: Moderate or moderately rapid in the upper part; rapid in the lower part
Landforms: Outwash plains and drainageways within moraines
Parent material: Loamy sediment overlying outwash
Slope: 0 to 1 percent

Taxonomic class: Coarse-loamy, mixed, frigid Typic Haplaquolls

Typical Pedon

Forada loam; 725 feet west and 1,250 feet south of the northeast corner of sec. 28, T. 134 N., R. 34 W.

Ap—0 to 11 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary.
A—11 to 15 inches; very dark gray (10YR 3/1) loam, very dark grayish brown (10YR 3/2) dry; common fine faint dark grayish brown (10YR 4/2) and common medium distinct dark brown (7.5YR 3/4) mottles; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
Bg—15 to 20 inches; olive gray (5Y 4/2) loam; common medium prominent dark brown (7.5YR 4/4) and strong brown (7.5YR 4/6) and few fine faint olive gray (5Y 4/2) mottles; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
2BCg—20 to 25 inches; olive gray (5Y 4/2) sandy loam; few fine distinct light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
2Cg1—25 to 32 inches; dark grayish brown (2.5Y 4/2) coarse sand; common medium faint light olive brown (2.5Y 5/6) mottles; single grain; loose; neutral; clear smooth boundary.
2Cg2—32 to 60 inches; grayish brown (2.5Y 5/2) coarse sand; common medium distinct yellowish brown (10YR 5/6) and many coarse faint light olive brown (2.5Y 5/6) mottles; single grain; loose; slightly effervescent; mildly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 50 inches
Thickness of the mollic epipedon: 10 to 24 inches

Ap and A horizons:
Hue—10YR, 2.5Y, 5Y, or neutral
Value—2 or 3
Chroma—0 or 1
Texture—loam or mucky loam
Content of rock fragments—0 to 10 percent gravel

Bg horizon:
Hue—2.5 or 5Y
Value—4 or 5
Chroma—1 or 2
Texture—loam or sandy loam
Content of rock fragments—0 to 10 percent gravel

2BCg horizon:
Colors and textures—similar to those of the B and 2C horizons

2Cg horizon:
Hue—10YR to 5Y
Value—4 to 6
Chroma—1 to 6
Texture—sand, coarse sand, or gravelly coarse sand
Content of rock fragments—0 to 35 percent gravel

Fordum Series

Drainage class: Poorly drained
Permeability: Moderate or moderately rapid in the upper part; moderately rapid in the lower part
Landform: Flood plains
Parent material: Alluvium
Slope: 0 to 1 percent

Taxonomic class: Coarse-loamy, mixed, nonacid, frigid Mollic Fluvaquents

Typical Pedon

Fordum silt loam, occasionally flooded; 2,350 feet west

and 1,850 feet north of the southeast corner of sec. 15, T. 134 N., R. 33 W.

A—0 to 8 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; friable; slightly acid; abrupt smooth boundary.

Cg1—8 to 20 inches; stratified very dark grayish brown (10YR 3/2) and dark grayish brown (2.5Y 4/2) silt loam; common fine distinct strong brown (7.5YR 4/6) and common fine faint grayish brown (10YR 5/2) mottles; few fine distinct black (10YR 2/1) clay flows; weak medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

Cg2—20 to 22 inches; dark grayish brown (2.5Y 4/2) loamy fine sand; common fine distinct strong brown (7.5YR 4/6) and many fine distinct dark grayish brown (10YR 4/2) mottles; single grain; very friable; neutral; abrupt smooth boundary.

Cg3—22 to 28 inches; dark grayish brown (2.5Y 4/2) loam; many coarse faint dark grayish brown (10YR 4/2) and dark gray (10YR 4/1) and many medium prominent strong brown (7.5YR 4/6 and 5/8) mottles; massive; firm; neutral; clear smooth boundary.

Cg4—28 to 35 inches; dark grayish brown (2.5Y 4/2) silt loam; many medium prominent strong brown (7.5YR 4/6 and 5/8) and few fine distinct dark brown (7.5YR 3/2) mottles; massive; firm; neutral; clear smooth boundary.

2Cg5—35 to 60 inches; light olive gray (5Y 6/2) and yellowish brown (10YR 5/6), stratified fine sand, sand, loam, and silt loam; common medium prominent strong brown (7.5YR 5/8) mottles; massive; friable; mildly alkaline.

Range in Characteristics

A horizon:
Hue—10YR, 2.5Y, or neutral
Value—2 or 3
Chroma—0 to 2
Texture—silt loam

Cg horizon:
Hue—10YR, 2.5Y, 5Y, or neutral
Value—3 to 5
Chroma—0 to 3
Texture—loam, sandy loam, fine sandy loam, loamy fine sand, very fine sand, fine sand, or silt loam

2Cg horizon:
Hue—10YR, 2.5Y, 5Y, or neutral
Value—4 to 6
Chroma—0 to 4
Texture—sand, loamy sand, loam, silt loam, fine sand, or loamy fine sand

Friendship Series

Drainage class: Moderately well drained
Permeability: Rapid
Landforms: Outwash plains and drumlins
Parent material: Outwash material
Slope: 0 to 6 percent

Taxonomic class: Mixed, frigid Typic Udipsamments

Typical Pedon

Friendship loamy sand, in an area of Friendship-Meehan loamy sands; 1,120 feet south and 1,420 feet west of the northeast corner of sec. 19, T. 135 N., R. 33 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; very friable; slightly acid; abrupt smooth boundary.

E—8 to 13 inches; dark grayish brown (10YR 4/2) sand, brown (10YR 5/3) dry; single grain; loose; moderately acid; clear smooth boundary.

Bw1—13 to 41 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; dark brown (10YR 4/3) coatings on faces of peds; slightly acid; clear smooth boundary.

Bw2—41 to 46 inches; brown (10YR 5/3) sand; common fine faint dark yellowish brown (10YR 4/4) and common distinct dark brown (7.5YR 4/4) mottles; single grain; loose; slightly acid; abrupt smooth boundary.

C1—46 to 54 inches; dark grayish brown (10YR 4/2) sand; few fine faint dark gray (10YR 4/1) and common fine distinct yellowish brown (10YR 5/4) mottles; single grain; loose; slightly acid; abrupt smooth boundary.

C2—54 to 60 inches; light brownish gray (2.5Y 6/2) sand; common medium distinct light olive brown (2.5Y 5/4) and dark grayish brown (10YR 4/2) mottles; single grain; loose; slightly acid.

Range in Characteristics

Content of rock fragments: 0 to 10 percent gravel

Ap and A horizons (when present):
Hue—7.5YR or 10YR
Value—2 or 3
Chroma—1 or 2
Texture—loamy sand

E horizon:
Hue—7.5YR or 10YR
Value—4 to 6
Chroma—2 or 3
Texture—loamy sand or sand

Bw horizon:
Hue—7.5YR or 10YR
Value—4 or 5
Chroma—3 to 6
Texture—loamy sand or sand

C horizon:
Hue—2.5Y, 10YR, or 7.5YR
Value—4 to 6
Chroma—2 to 4
Texture—sand

2C horizon (when present):
Texture—sandy loam with strata of loamy sand

Graycalm Series

Drainage class: Somewhat excessively drained
Permeability: Rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope: 0 to 3 percent

Taxonomic class: Mixed, frigid Alfic Udipsamments

Typical Pedon

Graycalm loamy sand; 1,025 feet north and 925 feet east of the southwest corner of sec. 26, T. 137 N., R. 35 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; medium acid; abrupt smooth boundary.

Bt1—9 to 14 inches; brown (10YR 4/3) loamy sand; moderate coarse subangular blocky structure; very friable; common faint dark brown (10YR 4/3) clay films on faces of peds; slightly acid; abrupt smooth boundary.

Bt2—14 to 26 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; common faint dark brown (7.5YR 3/4) iron and clay bridges between sand grains; thin dark brown (7.5YR 3/4) lamellae; about 8 percent coarse fragments; slightly acid; clear smooth boundary.

Bt3—26 to 33 inches; dark yellowish brown (10YR 4/4) coarse sand; single grain; loose; common distinct dark brown (7.5YR 3/2 and 3/4) clay bridges between sand grains; about 10 percent coarse fragments; neutral; clear wavy boundary.

Bt4—33 to 39 inches; brown (7.5YR 4/4) gravelly coarse sand; single grain; very friable; common distinct dark brown (7.5YR 3/2) clay coatings on sand grains; about 20 percent coarse fragments; neutral; clear wavy boundary.

BC—39 to 44 inches; yellowish brown (10YR 5/4) sand; single grain; loose; few faint dark brown (7.5YR 3/4) clay bridges between sand grains; about 7 percent coarse fragments; neutral; gradual wavy boundary.

C—44 to 60 inches; brown (10YR 5/3) sand; single grain; loose; slightly effervescent; mildly alkaline.

Range in Characteristics

Depth to carbonates: 40 to more than 60 inches
Content of rock fragments: 0 to 20 percent gravel
Other characteristics: E horizon present in some pedons

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loamy sand

Bt horizon:
Hue—10YR or 7.5YR
Value—3 to 5
Chroma—2 to 4
Texture—sand, coarse sand, loamy sand, or loamy coarse sand that is gravelly in some pedons

BC horizon:
Colors and textures—similar to those of the Bt and C horizons

C horizon:
Hue—10YR or 2.5Y
Value—5 to 7
Chroma—2 to 4
Texture—coarse sand, sand, gravelly coarse sand, or gravelly sand

The Graycalm soils in this county have a slightly thicker argillic horizon than is typical for the series. This difference, however, does not alter the usefulness or behavior of the soils.

Haug Series

Drainage class: Very poorly drained
Permeability: Moderate or moderately rapid in the upper part; moderate in the lower part
Landform: Ground moraines
Parent material: Highly decomposed herbaceous plant material over mineral material
Slope: 0 to 1 percent

Taxonomic class: Coarse-loamy, mixed (calcareous), frigid Histic Humaquepts

Typical Pedon

Haug muck; 2,500 feet west and 100 feet south of the northeast corner of sec. 11, T. 135 N., R. 35 W.

Oa—0 to 12 inches; dark reddish brown (5YR 2/2, rubbed) and black (N 2/0, broken) muck; about 30

percent fibers unrubbed, about 5 percent rubbed; strong medium granular structure; neutral; abrupt smooth boundary.

A—12 to 16 inches; black (10YR 2/1) loam; moderate fine granular structure; sticky; neutral; clear smooth boundary.

Cg1—16 to 25 inches; olive gray (5Y 5/2) sandy loam; common medium faint light gray (5Y 6/1) and common medium distinct strong brown (7.5YR 5/6) and yellowish brown (10YR 5/6) mottles; massive; friable; strongly effervescent; moderately alkaline; gradual smooth boundary.

Cg2—25 to 39 inches; olive gray (5Y 5/2) sandy loam; common medium faint light gray (5Y 6/1) and few medium prominent brown (7.5YR 5/4) mottles; massive; friable; strongly effervescent; moderately alkaline; gradual smooth boundary.

Cg3—39 to 60 inches; olive gray (5Y 5/2) sandy loam; common coarse prominent yellowish brown (10YR 5/6) and brown (7.5YR 4/4) mottles; massive; friable; strongly effervescent; mildly alkaline.

Range in Characteristics

Depth to carbonates: 8 to 16 inches
Content of rock fragments: 0 to 15 percent gravel

Oa horizon:
Hue—10YR, 2.5Y, 5Y, or neutral
Value—2 or 3
Chroma—0 to 2
Thickness—8 to 16 inches
Kind of material—sapric
Content of fibers—20 to 50 percent unrubbed; 0 to 10 percent rubbed

A horizon:
Hue—10YR, 2.5Y, 5Y, or neutral
Value—2 or 3
Chroma—0 to 2
Texture—loam, sandy loam, fine sandy loam, or silt loam

Cg horizon:
Hue—2.5Y or 5Y
Value—4 to 7
Chroma—1 or 2
Texture—loam, fine sandy loam, or sandy loam

Huntersville Series

Drainage class: Moderately well drained
Permeability: Rapid in the upper part; moderately slow to very slow in the lower part
Landform: Drumlins
Parent material: Glacial outwash and dense till
Slope: 1 to 6 percent

Taxonomic class: Coarse-loamy, mixed Aquic Eutroboralfs

Typical Pedon

Huntersville loamy fine sand, 1 to 6 percent slopes; 1,320 feet south and 495 feet west of the northeast corner of sec. 20, T. 135 N., R. 34 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; slightly acid; abrupt smooth boundary.

E—7 to 12 inches; dark brown (10YR 4/3) loamy sand, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; very friable; slightly acid; clear smooth boundary.

Bw—12 to 24 inches; yellowish brown (10YR 5/4) cobbly loamy sand; few fine faint light brownish gray (2.5Y 6/2) and few fine distinct strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; very friable; about 20 percent coarse fragments concentrated in the lower part; neutral; clear smooth boundary.

2Bt—24 to 40 inches; yellowish brown (10YR 5/4) sandy loam; common fine faint grayish brown (10YR 5/2) and common fine distinct brownish yellow (10YR 6/6) mottles; moderate medium subangular blocky structure; friable; few faint dark yellowish brown (10YR 4/4) clay films on faces of peds and in pores; about 3 percent coarse fragments; neutral; clear wavy boundary.

2Cd—40 to 60 inches; yellowish brown (10YR 5/4) sandy loam; common medium distinct light brownish gray (2.5Y 6/2) and dark yellowish brown (10YR 4/6) mottles; weak thick platy fragments; about 3 percent coarse fragments; firm; neutral; clear wavy boundary.

Range in Characteristics

Depth to carbonates: 40 to more than 60 inches
Other characteristics: E/B and B/E horizons present in some pedons

Ap horizon:
Hue—10YR
Value—2 to 4
Chroma—1 to 3
Texture—loamy fine sand
Content of rock fragments—0 to 5 percent gravel

E horizon:
Hue—10YR or 2.5Y
Value—4 or 5
Chroma—2 or 3
Texture—loamy sand, sand, loamy fine sand, or fine sand

Content of rock fragments—0 to 5 percent gravel

Bw horizon:
Hue—10YR
Value—4 to 6
Chroma—3 to 6
Texture—loamy sand or sand that is gravelly or cobbly in some pedons
Content of rock fragments—5 to 30 percent gravel; 0 to 15 percent cobbles

2Bt horizon:
Hue—10YR or 2.5Y
Value—4 to 6
Chroma—3 to 6
Texture—sandy loam
Content of rock fragments—0 to 15 percent gravel; 0 to 10 percent cobbles

2Cd horizon:
Hue—10YR or 2.5Y
Value—5 to 7
Chroma—2 to 4
Texture—sandy loam
Content of rock fragments—0 to 15 percent gravel; 0 to 10 percent cobbles

Isan Series

Drainage class: Poorly drained
Permeability: Rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope: 0 to 1 percent

Taxonomic class: Sandy, mixed, frigid Typic Haplaquolls

Typical Pedon

Isan loamy sand; 2,290 feet west and 25 feet south of the northeast corner of sec. 1, T. 134 N., R. 35 W.

A—0 to 13 inches; black (10YR 2/1) loamy sand, very dark gray (10YR 3/1) dry; weak very fine granular structure; very friable; neutral; clear smooth boundary.

AB—13 to 21 inches; very dark grayish brown (10YR 3/2) sand, dark grayish brown (10YR 4/2) dry; few fine faint brown (7.5YR 4/2) mottles; single grain; loose; neutral; gradual smooth boundary.

Bg—21 to 30 inches; dark grayish brown (2.5Y 4/2) sand; common fine distinct brown (7.5YR 4/4) mottles; single grain; loose; slightly acid; gradual clear boundary.

Cg—30 to 60 inches; grayish brown (2.5Y 5/2) sand; common fine distinct strong brown (7.5YR 5/6) and olive brown (2.5Y 4/4) mottles; single grain; loose; slightly acid.

Range in Characteristics

Thickness of the mollic epipedon: 10 to 24 inches

A horizon:
Hue—10YR, 2.5Y, 5Y, or neutral
Value—2 or 3
Chroma—0 to 2
Texture—sandy loam or loamy sand

AB horizon:
Colors and textures—similar to those of the A and B horizons

Bg horizon:
Hue—10YR, 2.5Y, 5Y, or neutral
Value—4 or 5
Chroma—0 to 2
Texture—sand, coarse sand, loamy sand, or loamy coarse sand

Cg horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—1 or 2
Texture—coarse sand or sand

Leafriver Series

Drainage class: Very poorly drained
Permeability: Moderately rapid or moderate in the upper part; rapid in the lower part
Landform: Outwash plains
Parent material: Thin organic mantle over sandy outwash sediment
Slope: 0 to 1 percent

Taxonomic class: Sandy, mixed, frigid Histic Humaquepts

Typical Pedon

Leafriver muck; 850 feet west and 250 feet south of the northeast corner of sec. 20, T. 136 N., R. 33 W.

Oa—0 to 9 inches; very dark brown (10YR 2/2, rubbed) and black (10YR 2/1, broken) muck; moderate medium platy structure; very friable; fibers are herbaceous; medium acid; clear smooth boundary.

A—9 to 14 inches; black (N 2/0) sandy loam; moderate fine and medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

Cg1—14 to 28 inches; dark grayish brown (2.5Y 4/2) loamy sand; few fine faint dark gray (10YR 4/1) mottles; weak fine and medium subangular blocky structure; very friable; neutral; gradual wavy boundary.

Cg2—28 to 60 inches; grayish brown (2.5Y 5/2) loamy sand; common medium distinct brown (10YR 5/3) mottles; massive; very friable; neutral.

Range in Characteristics

Oa horizon:
Hue—7.5YR or 10YR
Value—2 or 3
Chroma—0 to 2
Thickness—8 to 16 inches
Kind of material—sapric
Content of fibers—20 to 50 percent unrubbed; 0 to 10 percent rubbed

A horizon:
Hue—10YR, 2.5Y, 5Y, or neutral
Value—2 or 3
Chroma—0 or 1
Texture—sand, fine sand, loamy sand, loamy coarse sand, loamy fine sand, coarse sandy loam, sandy loam, fine sandy loam, or loam

Cg horizon:
Hue—10YR to 5Y
Value—4 to 7
Chroma—1 or 2
Texture—coarse sand, sand, fine sand, loamy coarse sand, loamy sand, or loamy fine sand

Mahtomedi Series

Drainage class: Excessively drained
Permeability: Rapid
Landforms: Outwash plains and drumlins
Parent material: Glacial outwash
Slope: 1 to 8 percent

Taxonomic class: Mixed, frigid Typic Udipsamments

Typical Pedon

Mahtomedi loamy sand, 1 to 8 percent slopes; 1,525 feet south and 150 feet east of the northwest corner of sec. 35, T. 135 N., R. 33 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; very friable; about 10 percent gravel; slightly acid; abrupt smooth boundary.

Bw1—8 to 18 inches; strong brown (7.5YR 4/6) gravelly sand; single grain; loose; about 20 percent gravel; slightly acid; clear smooth boundary.

Bw2—18 to 31 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; about 12 percent gravel; slightly acid; clear smooth boundary.

BC—31 to 35 inches; dark yellowish brown (10YR 4/4) gravelly sand; single grain; loose; about 30 percent gravel; neutral; clear smooth boundary.

C—35 to 60 inches; brown (10YR 5/3) gravelly sand; single grain; loose; about 30 percent gravel; strongly effervescent; mildly alkaline.

Range in Characteristics

Depth to carbonates: 30 to more than 60 inches

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 to 3
Texture—loamy sand
Content of rock fragments—5 to 10 percent gravel

Bw horizon:
Hue—7.5YR or 10YR
Value—4 or 5
Chroma—4 to 6
Texture—gravelly coarse sand, gravelly sand, coarse sand, or sand
Content of rock fragments—5 to 35 percent gravel

BC horizon:
Colors and textures—similar to those of the Bw and C horizons

C horizon:
Hue—10YR
Value—5 or 6
Chroma—3 or 4
Texture—gravelly sand or gravelly coarse sand
Content of rock fragments—15 to 35 percent gravel

Markey Series

Drainage class: Very poorly drained
Permeability: Moderately slow to moderately rapid in the upper part; rapid in the lower part
Landforms: Outwash plains and ground moraines
Parent material: Highly decomposed herbaceous plant material over mineral material
Slope: 0 to 2 percent

Taxonomic class: Sandy or sandy-skeletal, mixed, euic Terric Borosaprists

Typical Pedon

Markey muck (fig. 11); 20 feet north and 2,100 feet east of the southwest corner of sec. 9, T. 135 N., R. 35 W.

Oa—0 to 26 inches; black (N 2/0, rubbed) muck; about 25 percent fibers unrubbed, less than 5 percent rubbed; massive; most fibers are herbaceous; neutral; abrupt smooth boundary.

Cg1—26 to 29 inches; pale olive (5Y 6/3) and light olive gray (5Y 6/2) loam; massive; sticky; neutral; clear smooth boundary.

Figure 11.—Typical profile of Markey muck.

Cg2—29 to 60 inches; greenish gray (5GY 5/1) sand; single grain; loose; slightly effervescent; mildly alkaline.

Range in Characteristics

Oa horizon:
Hue—10YR, 7.5YR, or neutral
Value—2 or 3
Chroma—0 to 2
Thickness—16 to 50 inches
Kind of material—sapric
Content of fibers—5 to 60 percent unrubbed; 0 to 20 percent rubbed

Cg horizon:
Hue—10YR to 5G
Value—4 to 6
Chroma—1 to 4
Texture—sand, coarse sand, or loam

Meehan Series

Drainage class: Somewhat poorly drained
Permeability: Rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope: 0 to 3 percent

Taxonomic class: Mixed, frigid Aquic Udipsamments

Typical Pedon

Meehan loamy sand, in an area of Friendship-Meehan loamy sands; 150 feet north and 200 feet west of the southeast corner of sec. 7, T. 137 N., R. 34 W.

Ap—0 to 8 inches; black (10YR 2/1) loamy sand, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; slightly acid; clear smooth boundary.

E—8 to 11 inches; dark grayish brown (10YR 4/2) loamy sand, brown (10YR 5/3) dry; weak fine subangular blocky structure; very friable; slightly acid; clear smooth boundary.

Bw1—11 to 17 inches; dark yellowish brown (10YR 4/4) sand; many coarse distinct dark grayish brown (10YR 4/2) and strong brown (7.5YR 4/6) mottles; single grain; loose; medium acid; gradual wavy boundary.

Bw2—17 to 40 inches; strong brown (7.5YR 4/6) sand; common fine distinct grayish brown (2.5Y 5/2) mottles; single grain; loose; medium acid; clear smooth boundary.

C—40 to 60 inches; light gray (10YR 7/2) sand; single grain; loose; medium acid.

Range in Characteristics

Content of rock fragments: 0 to 10 percent gravel

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loamy sand

E horizon:
Hue—7.5YR or 10YR
Value—4 to 6

Chroma—2 or 3
Texture—loamy sand or sand

Bw horizon:
Hue—7.5YR or 10YR
Value—4 to 6
Chroma—2 to 8
Texture—loamy sand or sand

C horizon:
Hue—7.5YR or 10YR
Value—4 to 7
Chroma—2 to 4
Texture—sand or coarse sand

Menahga Series

Drainage class: Excessively drained
Permeability: Rapid
Landforms: Outwash plains and drumlins
Parent material: Glacial outwash
Slope: 0 to 45 percent

Taxonomic class: Mixed, frigid Typic Udipsamments

Typical Pedon

Menahga loamy coarse sand, 2 to 6 percent slopes; 1,200 feet west and 1,400 feet south of the northeast corner of sec. 25, T. 135 N., R. 35 W.

A—0 to 2 inches; black (10YR 2/1) loamy coarse sand, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; very friable; medium acid; abrupt smooth boundary.

AB—2 to 4 inches; very dark grayish brown (10YR 3/2) coarse sand; common very dark gray (10YR 3/1) and dark gray (10YR 4/1) stains; weak fine and medium subangular blocky structure; very friable; medium acid; clear wavy boundary.

Bw1—4 to 10 inches; dark brown (10YR 4/3) coarse sand; very weak fine and medium subangular blocky structure; very friable; medium acid; clear wavy boundary.

Bw2—10 to 19 inches; dark yellowish brown (10YR 4/4) coarse sand; very weak fine and medium subangular blocky structure; very friable; medium acid; clear wavy boundary.

BC—19 to 24 inches; brown (10YR 5/3) coarse sand; single grain; loose; medium acid; gradual wavy boundary.

C—24 to 60 inches; pale brown (10YR 6/3) coarse sand; single grain; loose; medium acid.

Range in Characteristics

Content of rock fragments: 0 to 10 percent gravel
Other characteristics: E horizon present in some pedons

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loamy sand or loamy coarse sand

AB horizon (when present):
Hue—10YR
Value—3 or 4
Chroma—2
Texture—coarse sand or loamy sand

Bw horizon:
Hue—10YR or 7.5YR
Value—4 or 5
Chroma—3 to 6
Texture—coarse sand or sand

BC horizon:
Colors and textures—similar to those of the Bw and C horizons

C horizon:
Hue—10YR or 7.5YR
Value—5 or 6
Chroma—3 to 5
Texture—sand or coarse sand

2C horizon (when present):
Texture—sandy loam with strata of loamy sand

Nymore Series

Drainage class: Excessively drained
Permeability: Rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope: 1 to 12 percent

Taxonomic class: Mixed, frigid Typic Udipsamments

Typical Pedon

Nymore loamy sand, 1 to 3 percent slopes; 950 feet west and 225 feet north of the southeast corner of sec. 30, T. 135 N., R. 34 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; very friable; slightly acid; abrupt smooth boundary.

BA—8 to 11 inches; brown (10YR 4/3) and dark brown (10YR 3/3) sand; single grain; loose; slightly acid; clear smooth boundary.

Bw1—11 to 23 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; neutral; clear smooth boundary.

Bw2—23 to 33 inches; yellowish brown (10YR 5/4) sand; single grain; loose; about 1 percent gravel; neutral; clear smooth boundary.

C—33 to 60 inches; light yellowish brown (10YR 6/4) sand; single grain; loose; slightly acid.

Range in Characteristics

Depth to carbonates: 48 to more than 60 inches
Content of rock fragments: 0 to 10 percent gravel

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 to 3
Texture—loamy sand

BA horizon:
Colors and textures—similar to those of the A and Bw horizons

Bw horizon:
Hue—7.5YR or 10YR
Value—3 to 6
Chroma—3 to 6
Texture—sand, coarse sand, loamy coarse sand, or loamy sand

C horizon:
Hue—10YR or 7.5YR
Value—5 to 7
Chroma—2 to 6
Texture—sand or coarse sand

Oylen Series

Drainage class: Moderately well drained
Permeability: Moderately rapid or moderate in the upper part; rapid in the lower part
Landform: Outwash plains
Parent material: Loamy sediment over outwash material
Slope: 0 to 3 percent

Taxonomic class: Coarse-loamy, mixed Aquic Argiborolls

Typical Pedon

Oylen sandy loam; 1,250 feet south and 350 feet west of the northeast corner of sec. 27, T. 134 N., R. 34 W.

Ap—0 to 10 inches; black (10YR 2/1) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

Bt—10 to 18 inches; dark yellowish brown (10YR 4/4) sandy loam; weak fine and medium subangular blocky structure; friable; many thin dark brown (10YR 3/3) and very dark grayish brown (10YR 3/2) clay films on faces of peds; slightly acid; abrupt smooth boundary.

2Bw1—18 to 24 inches; dark yellowish brown (10YR 4/4) coarse sand; single grain; loose; about 13 percent coarse fragments; neutral; clear smooth boundary.

2Bw2—24 to 38 inches; yellowish brown (10YR 5/4) sand; common medium distinct dark grayish brown (10YR 4/2), common fine distinct brownish yellow (10YR 6/8), and few fine distinct light gray (2.5Y 7/2) mottles; single grain; loose; about 2 percent coarse fragments; neutral; clear smooth boundary.

2C—38 to 60 inches; light brownish gray (10YR 6/2) gravelly coarse sand; few fine faint yellowish brown (10YR 5/4) mottles; single grain; loose; about 16 percent coarse fragments; strongly effervescent; mildly alkaline.

Range in Characteristics

Depth to carbonates: 36 to more than 60 inches
Thickness of the mollic epipedon: 7 to 16 inches

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 to 3
Texture—sandy loam
Content of rock fragments—0 to 10 percent gravel

Bt horizon:
Hue—10YR
Value—4 or 5
Chroma—3 to 6
Texture—sandy loam or loam
Content of rock fragments—0 to 10 percent gravel

2Bw horizon:
Hue—10YR, 7.5YR, or 2.5Y
Value—4 or 5
Chroma—2 to 4
Texture—loamy sand, sand, coarse sand, or loamy coarse sand that is gravelly in some pedons
Content of rock fragments—0 to 20 percent gravel

2C horizon:
Hue—10YR or 2.5Y
Value—4 to 6
Chroma—2 to 4
Texture—sand or coarse sand that is gravelly in some pedons
Content of rock fragments—10 to 30 percent gravel

Paddock Series

Drainage class: Somewhat poorly drained
Permeability: Moderate in the upper part; moderately slow to very slow in the lower part
Landform: Drumlins
Parent material: Glacial till
Slope: 0 to 2 percent

Taxonomic class: Coarse-loamy, mixed, frigid Udollic Ochraqualfs

Typical Pedon

Paddock loam, in an area of Paddock complex; 2,275 feet west and 250 feet north of the southeast corner of sec. 10, T. 135 N., R. 35 W.

A—0 to 5 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; neutral; abrupt smooth boundary.

E1—5 to 10 inches; dark grayish brown (2.5Y 4/2) sandy loam, light brownish gray (2.5Y 6/2) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate thin platy structure; very friable; slightly acid; clear smooth boundary.

E2—10 to 14 inches; grayish brown (2.5Y 5/2) sandy loam, light gray (2.5Y 7/2) dry; common medium distinct yellowish brown (10YR 5/6) mottles; weak thin platy structure; very friable; medium acid; clear smooth boundary.

B/E—14 to 19 inches; dark yellowish brown (10YR 4/4) sandy loam (Bt) and brown (10YR 5/3) sandy loam (E); many fine and medium distinct strong brown (7.5YR 4/6) mottles; moderate medium subangular blocky structure; friable; common distinct dark grayish brown (10YR 4/2) clay films in pores and on faces of peds; about 3 percent coarse fragments; slightly acid; clear wavy boundary.

Bt1—19 to 29 inches; light olive brown (2.5Y 5/4) sandy loam; common fine distinct strong brown (7.5YR 5/8) and yellowish red (5YR 4/6) and many medium and coarse distinct grayish brown (10YR 5/2) mottles; moderate medium prismatic structure parting to strong medium angular blocky; firm; common distinct dark grayish brown (10YR 4/2) clay films in pores and on faces of peds; about 3 percent coarse fragments; medium acid; clear wavy boundary.

Bt2—29 to 41 inches; dark yellowish brown (10YR 4/4) sandy loam; few fine distinct brown (7.5YR 4/4) and common coarse distinct light brownish gray (2.5Y 6/2) mottles; moderate medium subangular blocky structure; firm; common distinct dark grayish brown (10YR 4/2) clay films on faces of peds and in pores; slightly acid; gradual smooth boundary.

BC—41 to 50 inches; yellowish brown (10YR 5/4) sandy loam; few fine distinct brown (7.5YR 4/4) and many medium distinct light brownish gray (2.5Y 6/2) mottles; weak very thick platy structure; firm; neutral; gradual smooth boundary.

Cd—50 to 60 inches; yellowish brown (10YR 5/4) sandy loam; weak very thick platy fragments; very firm, hard when dry; about 3 percent coarse fragments; strongly effervescent; moderately alkaline.

Range in Characteristics

Depth to carbonates: 40 to 55 inches

Content of rock fragments: 0 to 10 percent gravel; 0 to 3 percent stones

A horizon:
- Hue—10YR
- Value—2 or 3
- Chroma—1 or 2
- Texture—loam

E horizon:
- Hue—10YR or 2.5Y
- Value—4 or 5
- Chroma—1 or 2
- Texture—sandy loam or loam

B/E horizon:
- Colors and textures—similar to those of the E and Bt horizons

Bt horizon:
- Hue—10YR or 2.5Y
- Value—4 or 5
- Chroma—2 to 4
- Texture—sandy loam or loam

BC horizon:
- Colors and textures—similar to those of the Bt and Cd horizons

Cd horizon:
- Hue—10YR
- Value—4 to 6
- Chroma—3 to 6
- Texture—sandy loam or loamy sand

Redeye Series

Drainage class: Well drained

Permeability: Rapid in the upper part; moderately slow to very slow in the lower part

Landform: Drumlins

Parent material: Sandy glacial outwash over dense till

Slope: 1 to 12 percent

Taxonomic class: Loamy, mixed Arenic Eutroboralfs

Typical Pedon

Redeye loamy sand, 1 to 6 percent slopes; 250 feet south and 25 feet east of the northwest corner of sec. 23, T. 138 N., R. 34 W.

A—0 to 3 inches; very dark gray (10YR 3/1) loamy sand, grayish brown (10YR 5/2) dry; moderate medium granular structure; very friable; strongly acid; abrupt smooth boundary.

E—3 to 18 inches; brown (10YR 5/3) sand, pale brown (10YR 6/3) dry; weak fine subangular blocky

structure; very friable; strongly acid; about 1 percent coarse fragments; clear wavy boundary.
Bw—18 to 26 inches; yellowish brown (10YR 5/4) loamy sand; weak medium subangular blocky structure; very friable; about 5 percent coarse fragments; slightly acid; clear smooth boundary.
2Bt1—26 to 38 inches; yellowish brown (10YR 5/4) sandy loam; moderate coarse prismatic structure; friable; about 3 percent coarse fragments; common pale brown (10YR 6/3) coatings of clean sand on faces of peds; common faint dark yellowish brown (10YR 4/4) clay films on faces of peds and in pores; medium acid; clear wavy boundary.
2Bt2—38 to 52 inches; dark yellowish brown (10YR 4/4) sandy loam; weak thick platy structure; firm; about 3 percent coarse fragments; common faint dark brown (10YR 4/3) clay films on faces of peds and in pores; slightly acid; clear wavy boundary.
2Cd—52 to 60 inches; light yellowish brown (10YR 6/4) sandy loam; moderate thick platy fragments; firm; about 3 percent coarse fragments; strongly effervescent; moderately alkaline.

Range in Characteristics

Depth to carbonates: 48 to 60 inches
Other characteristics: BE, EB, B/E, and E/B horizons present in some pedons

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 to 3
Texture—loamy sand
Content of rock fragments—0 to 10 percent gravel

E horizon:
Hue—10YR or 2.5Y
Value—4 or 5
Chroma—2 or 3
Texture—sand, loamy sand, loamy fine sand, or fine sand
Content of rock fragments—0 to 10 percent gravel

Bw horizon:
Hue—10YR
Value—3 to 6
Chroma—3 to 6
Texture—sand, loamy sand, loamy coarse sand, or coarse sand
Content of rock fragments—0 to 10 percent gravel

2Bt horizon:
Hue—10YR
Value—4 or 5
Chroma—4 to 6
Texture—sandy loam
Content of rock fragments—0 to 10 percent gravel; 0 to 15 percent cobbles

2Cd horizon:
Hue—10YR or 2.5Y
Value—4 to 6
Chroma—4 or 5
Texture—sandy loam
Content of rock fragments—0 to 10 percent gravel; 0 to 10 percent cobbles

Rifle Series

Drainage class: Very poorly drained
Permeability: Moderate or moderately rapid
Landforms: Outwash plains and ground moraines
Parent material: Moderately decomposed, mostly herbaceous plant material
Slope: 0 to 2 percent

Taxonomic class: Euic Typic Borohemists

Typical Pedon

Rifle mucky peat; 50 feet south and 40 feet west of the northeast corner of sec. 32, T. 136 N., R. 34 W.

Oe1—0 to 16 inches; very dark brown (10YR 2/2, rubbed and broken) mucky peat; about 80 percent herbaceous fibers unrubbed, 20 percent rubbed; massive; strongly acid; gradual smooth boundary.
Oe2—16 to 60 inches; very dark brown (10YR 2/2, rubbed and broken) mucky peat; about 70 percent herbaceous fibers unrubbed, 25 percent rubbed; massive; strongly acid.

Range in Characteristics

Oe horizon:
Hue—5YR, 7.5YR, or 10YR
Value—2 to 4
Chroma—2 to 4
Thickness—60 to 100 inches
Kind of material—hemic
Content of fibers—60 to 80 percent unrubbed; 20 to 30 percent rubbed
Content of wood fragments more than 2 millimeters in size—0 to 15 percent

Rockwood Series

Drainage class: Well drained
Permeability: Moderate in the upper part; moderately slow to very slow in the lower part
Landform: Drumlins
Parent material: Glacial till
Slope: 2 to 18 percent

Taxonomic class: Coarse-loamy, mixed Mollic Eutroboralfs

Typical Pedon

Rockwood sandy loam, 6 to 12 percent slopes; 1,050 feet east and 30 feet north of the southwest corner of sec. 8, T. 135 N., R. 34 W.

A—0 to 4 inches; very dark grayish brown (10YR 3/2) sandy loam, gray (10YR 5/1) dry; moderate fine subangular blocky structure; very friable; neutral; abrupt smooth boundary.

AE—4 to 9 inches; very dark grayish brown (10YR 3/2) and brown (10YR 4/3) sandy loam, grayish brown (10YR 5/2) dry; weak thin platy structure; very friable; slightly acid; clear smooth boundary.

E—9 to 19 inches; brown (10YR 5/3) sandy loam; weak medium subangular blocky structure; very friable; medium acid; clear wavy boundary.

BE—19 to 26 inches; dark yellowish brown (10YR 4/4) gravelly sandy loam; moderate medium subangular blocky structure; friable; few dark brown (10YR 4/3) clay films on faces of peds; brown (10YR 5/3) sand that occurs as coatings on faces of peds and interfingers; about 15 percent coarse fragments; medium acid; clear wavy boundary.

Bt—26 to 37 inches; dark yellowish brown (10YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; common distinct dark yellowish brown (10YR 3/4) and dark brown (10YR 4/3) clay films on faces of peds; about 3 percent coarse fragments; medium acid; gradual wavy boundary.

BC—37 to 55 inches; yellowish brown (10YR 5/4) sandy loam; moderate medium platy structure; firm; few faint dark yellowish brown (10YR 4/6) clay films on faces of peds; about 3 percent coarse fragments; medium acid; gradual wavy boundary.

Cd—55 to 60 inches; yellowish brown (10YR 5/4) sandy loam; moderate medium platy fragments; firm; about 2 percent coarse fragments; slightly effervescent; mildly alkaline.

Range in Characteristics

Depth to carbonates: 40 to 60 inches

Content of rock fragments: 0 to 10 percent gravel; 0 to 10 percent cobbles

Other characteristics: EB, B/E, and E/B horizons present in some pedons

A horizon:
- Hue—10YR
- Value—2 or 3
- Chroma—1 to 3
- Texture—sandy loam

AE horizon (when present):
- Hue—10YR
- Value—3 or 4
- Chroma—2 or 3
- Texture—sandy loam

E horizon:
- Hue—10YR
- Value—4 to 6
- Chroma—2 to 4
- Texture—sandy loam or loamy sand

BE horizon:
- Colors and textures—similar to those of the E and Bt horizons

Bt horizon:
- Hue—10YR
- Value—4 or 5
- Chroma—3 or 4
- Texture—sandy loam or sandy clay loam

BC horizon:
- Colors and textures—similar to those of the Bt and Cd horizons

Cd horizon:
- Hue—10YR or 2.5Y
- Value—5 or 6
- Chroma—3 or 4
- Texture—sandy loam or loamy sand

Rondeau Series

Drainage class: Very poorly drained

Permeability: Moderately rapid to moderately slow in the upper part; very slow or slow in the lower part

Landform: Bogs

Parent material: Decomposed herbaceous plant material over limnic material

Slope: 0 to 1 percent

Taxonomic class: Marly, euic Limnic Borosaprists

Typical Pedon

Rondeau muck; 1,000 feet west and 1,800 feet north of the southeast corner of sec. 13, T. 135 N., R. 33 W.

Oa—0 to 38 inches; black (10YR 2/1, rubbed) muck; about 30 percent herbaceous fibers unrubbed, less than 5 percent rubbed; massive; very friable; slightly acid; clear smooth boundary.

Cg—38 to 60 inches; olive gray (5Y 5/2) marl; massive; friable; strongly effervescent; mildly alkaline.

Range in Characteristics

Depth to marl: 16 to 51 inches

Oa horizon:
Hue—10YR, 2.5Y, or neutral
Value—2 or 3
Chroma—0 to 2
Thickness—16 to 51 inches
Kind of material—sapric
Content of fibers—10 to 35 percent unrubbed; 0 to 10 percent rubbed

C horizon:
Hue—10YR, 2.5Y, or 5Y
Value—5 to 7
Chroma—1 or 2
Texture—marl that has texture similar to that of silt

Roscommon Series

Drainage class: Poorly drained
Permeability: Rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope: 0 to 2 percent

Taxonomic class: Mixed, frigid Mollic Psammaquents

Typical Pedon

Roscommon loamy sand; 1,475 feet south and 1,950 feet west of the northeast corner of sec. 14, T. 137 N., R. 34 W.

A—0 to 7 inches; black (10YR 2/1) loamy sand, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; few very fine roots; medium acid; abrupt smooth boundary.

Cg1—7 to 16 inches; light brownish gray (2.5Y 6/2) sand; single grain; loose; slightly acid; clear smooth boundary.

Cg2—16 to 31 inches; light brownish gray (2.5Y 6/2) sand; common medium prominent strong brown (7.5YR 5/6) mottles; single grain; loose; slightly acid; clear smooth boundary.

Cg3—31 to 45 inches; grayish brown (2.5Y 5/2) sand; common medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose; slightly acid; clear smooth boundary.

Cg4—45 to 53 inches; olive gray (5Y 5/2) sand; common fine distinct light brownish gray (10YR 6/2) and yellowish brown (10YR 5/4) mottles; single grain; loose; medium acid; clear smooth boundary.

Cg5—53 to 60 inches; gray (5Y 5/1) sand; many large distinct grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/4) mottles; single grain; loose; medium acid.

Range in Characteristics

Content of rock fragments: 0 to 5 percent gravel

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loamy sand

Cg horizon:
Hue—2.5Y or 5Y
Value—4 to 6
Chroma—1 to 3
Texture—loamy sand, sand, loamy fine sand, or fine sand

Runeberg Series

Drainage class: Very poorly drained
Permeability: Moderately slow or moderate in the upper part; moderately slow or slow in the lower part
Landform: Drumlins
Parent material: Glacial till
Slope: 0 to 2 percent

Taxonomic class: Coarse-loamy, mixed, frigid Typic Haplaquolls

Typical Pedon

Runeberg mucky loam; 400 feet south and 1,325 feet east of the northwest corner of sec. 23, T. 136 N., R. 35 W.

A1—0 to 3 inches; black (10YR 2/1) mucky loam, black (10YR 2/1) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A2—3 to 9 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

A3—9 to 13 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; common fine faint dark gray (10YR 4/1) and common fine distinct dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

Bg1—13 to 19 inches; dark grayish brown (10YR 4/2) loam; few medium distinct greenish gray (5GY 5/1) and gray (5Y 5/1) and common medium and coarse prominent dark brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

Bg2—19 to 26 inches; olive gray (5Y 5/2) sandy loam; common fine faint gray (5Y 5/1) and common medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable;

about 3 percent coarse fragments; neutral; clear smooth boundary.
Cg—26 to 60 inches; pale olive (5Y 6/3) sandy loam; common fine faint gray (5Y 5/1) and common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 5 percent coarse fragments; strongly effervescent; mildly alkaline.

Range in Characteristics

Depth to carbonates: 24 to 36 inches
Content of rock fragments: 0 to 10 percent gravel

A horizon:
Hue—10YR to 5Y
Value—2 or 3
Chroma—1 or 2
Texture—mucky loam

Bg horizon:
Hue—10YR, 2.5Y, or 5Y
Value—4 or 5
Chroma—1 or 2
Texture—sandy loam or loam

Cg horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—1 to 3
Texture—sandy loam

Seelyeville Series

Drainage class: Very poorly drained
Permeability: Moderately slow to moderately rapid
Landforms: Outwash plains and ground moraines
Parent material: Highly decomposed herbaceous plant material
Slope: 0 to 2 percent

Taxonomic class: Euic Typic Borosaprists

Typical Pedon

Seelyeville muck; 1,850 feet south and 250 feet east of the northwest corner of sec. 16, T. 137 N., R. 34 W.

Oa1—0 to 22 inches; black (10YR 2/1, rubbed) muck; about 44 percent fibers unrubbed, 7 percent rubbed; massive; nonsticky, friable; fibers are dominantly herbaceous; strongly acid; clear smooth boundary.
Oa2—22 to 52 inches; black (N 2/0, rubbed) muck; about 26 percent fibers unrubbed, 7 percent rubbed; massive; nonsticky; fibers are dominantly herbaceous; medium acid; clear smooth boundary.
Oa3—52 to 60 inches; black (N 2/0, rubbed) muck; about 30 percent fibers unrubbed, 6 percent rubbed; weak medium platy structure; nonsticky; fibers are dominantly herbaceous; strongly acid.

Range in Characteristics

Oa horizon:
Hue—7.5YR, 10YR, or neutral
Value—2 or 3
Chroma—0 to 3
Thickness—16 to 51 inches
Kind of material—sapric
Content of fibers—20 to 60 percent unrubbed; 0 to 10 percent rubbed

Staples Series

Drainage class: Poorly drained
Permeability: Rapid in the upper part; moderately slow to very slow in the lower part
Landform: Glacial drumlins
Parent material: Sandy mantle over dense glacial till
Slope: 0 to 2 percent

Taxonomic class: Loamy, mixed, frigid Arenic Ochraqualfs

Typical Pedon

Staples loamy sand; 1,875 feet east and 550 feet south of the northwest corner of sec. 18, T. 135 N., R. 33 W.

A—0 to 7 inches; very dark gray (10YR 3/1) loamy sand, dark grayish brown (10YR 4/2) dry; many fine distinct dark brown (7.5YR 3/2) and common fine faint dark grayish brown (10YR 4/2) mottles; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.
Eg1—7 to 15 inches; dark grayish brown (10YR 4/2) sand; many medium distinct yellowish brown (10YR 4/4) and common medium faint grayish brown (2.5Y 5/2) mottles; weak fine subangular blocky structure; very friable; neutral; clear smooth boundary.
Eg2—15 to 32 inches; grayish brown (2.5Y 5/2) sand; common medium distinct very dark grayish brown (10YR 3/2) and few fine distinct dark brown (10YR 4/3) mottles; single grain; loose; neutral; clear smooth boundary.
Eg3—32 to 36 inches; grayish brown (2.5Y 5/2) sand; common medium distinct dark grayish brown (10YR 4/2) mottles and common dark brown (7.5YR 3/4) oxide stains; single grain; loose; common black (N 2/0) and dark reddish brown (5YR 3/3) oxide concretions; neutral; clear smooth boundary.
2Btg—36 to 44 inches; olive gray (5Y 5/2) sandy loam; common medium distinct dark grayish brown (10YR 4/2) mottles and common dark brown (7.5YR 3/4) oxide stains; weak fine subangular blocky structure; firm; common distinct and faint dark brown (10YR 4/3) clay films on faces of peds and in pores; about

10 percent gravel; neutral; abrupt smooth boundary.
2Cd1—44 to 56 inches; olive gray (5Y 5/2) sandy loam; many coarse distinct greenish gray (5GY 5/1) mottles and few dark brown (7.5YR 4/4) oxide stains; massive; firm; about 5 percent gravel; mildly alkaline; clear smooth boundary.
2Cd2—56 to 60 inches; olive gray (5Y 4/2) sandy loam; common coarse faint greenish gray (5GY 5/1) mottles; massive; firm; common black (2.5Y 2/0) oxide concretions; about 5 percent gravel; mildly alkaline.

Range in Characteristics

Depth to carbonates: 48 to more than 60 inches
Content of rock fragments: 0 to 10 percent gravel

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loamy sand

Eg horizon:
Hue—10YR or 2.5Y
Value—4 to 6
Chroma—1 or 2
Texture—loamy sand or sand

2Btg horizon:
Hue—10YR, 2.5Y, or 5Y
Value—4 to 6
Chroma—1 or 2
Texture—sandy loam or sandy clay loam

2Cd horizon:
Hue—2.5Y or 5Y
Value—4 to 6
Chroma—1 to 3
Texture—sandy loam or loamy sand

Verndale Series

Drainage class: Well drained
Permeability: Moderately rapid or moderate in the upper part; rapid in the lower part
Landform: Outwash plains
Parent material: Loamy mantle over glacial outwash
Slope: 0 to 6 percent

Taxonomic class: Coarse-loamy, mixed Udic Argiborolls

Typical Pedon

Verndale sandy loam, 0 to 2 percent slopes; 2,390 feet north and 1,375 feet east of the southwest corner of sec. 26, T. 134 N., R. 33 W.

Ap—0 to 9 inches; black (10YR 2/1) sandy loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure; friable; slightly acid; abrupt smooth boundary.
Bt1—9 to 13 inches; dark brown (10YR 3/3) sandy loam; very dark grayish brown (10YR 3/2) coatings on faces of peds; moderate medium subangular blocky structure; friable; many distinct very dark brown (10YR 2/2) clay films on faces of peds; common very fine and fine roots; neutral; clear smooth boundary.
Bt2—13 to 19 inches; brown (10YR 4/3) sandy loam; moderate medium subangular blocky structure; friable; many distinct very dark grayish brown (10YR 3/2) clay films on faces of peds; few very fine and fine roots; about 2 percent fine gravel; slightly acid; clear smooth boundary.
2Bw1—19 to 28 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; about 2 percent gravel; neutral; clear wavy boundary.
2Bw2—28 to 49 inches; yellowish brown (10YR 5/4) coarse sand; single grain; loose; about 3 percent gravel; neutral; clear smooth boundary.
2C—49 to 60 inches; light yellowish brown (10YR 6/4) sand; few yellowish brown (10YR 5/4) strata of sand; single grain; loose; about 5 percent gravel; slightly effervescent; moderately alkaline.

Range in Characteristics

Depth to carbonates: 36 to more than 60 inches
Thickness of the mollic epipedon: 7 to 16 inches
Content of rock fragments: 0 to 10 percent gravel

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—sandy loam

Bt horizon:
Hue—10YR
Value—3 to 5
Chroma—3 or 4
Texture—sandy loam, fine sandy loam, or loam

2Bw horizon:
Hue—10YR or 7.5YR
Value—4 or 5
Chroma—3 to 6
Texture—loamy sand, loamy coarse sand, sand, or coarse sand

2C horizon:
Hue—10YR or 2.5Y
Value—4 to 6
Chroma—2 to 4
Texture—sand, coarse sand, or fine sand

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Formation of the Soils

Soil is produced by the action of soil-forming processes on materials deposited or accumulated by geologic forces. The characteristics of the soil in a given area are determined by (1) the composition of the parent material, (2) the climate under which the soil material has accumulated, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time that the forces of soil formation have acted on the soil material *(9)*.

Climate and plant and animal life, chiefly plants, act upon the parent material. The type of parent material and its resistance to weathering determine the kind and degree of soil development. Relief modifies the effect of climate, which in turn influences plant material. Time is needed for changes to occur in the parent material. The amount of time needed depends on the intensity of soil development.

All five factors of soil formation are interrelated. When one factor changes, changes in the other four factors result. The following paragraphs discuss the factors of soil formation as they relate to the soils in the survey area.

Parent Material

The soils in Wadena County formed in glacial till, in material sorted out by glacial meltwater, and in organic matter. About 60 percent of the soils formed in sandy and gravelly outwash, 25 percent in glacial till, and 15 percent in organic matter.

The Wadena drumlin field of the Wisconsin Glaciation is the most recent evidence of glacial action in the county. At one time this drumlin field extended across the entire county in a northeast to southwest alignment (fig. 12). The influence of meltwater from more recent glacial events has significantly altered the appearance of the drumlin field. The most evident drumlins are in the west-central part of the county, near Sebeka and Blue Grass. The landscape is gently sloping to sloping. Blowers, Paddock, Rockwood, and Runeberg soils formed in glacial till on the drumlins.

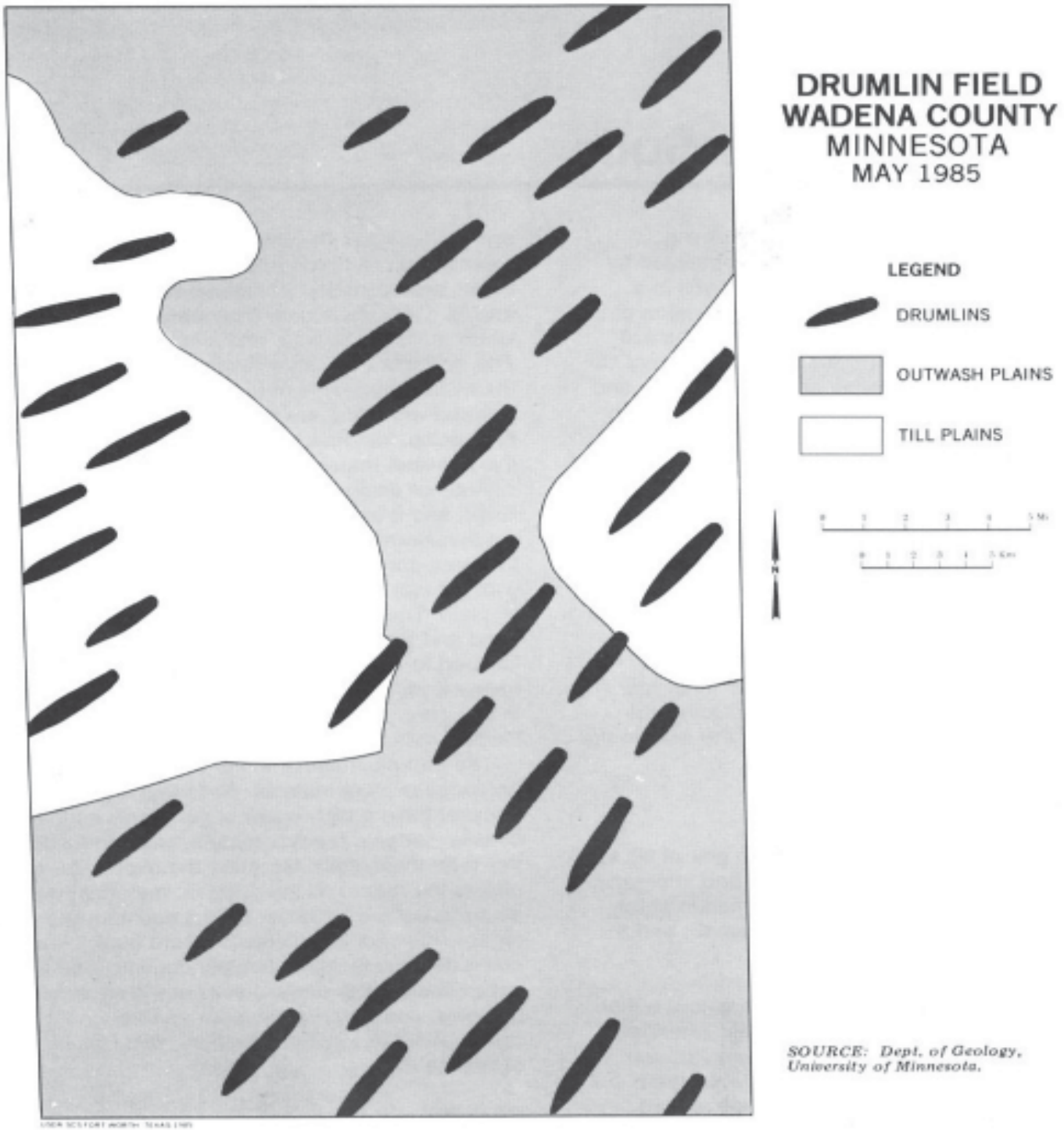
Two distinct glacial outwash areas are in the county. One area of outwash is generally north and east of the drumlin field and the Redeye and Leaf Rivers, and it extends into Hubbard and Cass Counties. The outwash in this area consists of material washed from the Itasca and St. Croix moraines. It is dominantly sand, some of which is fine or coarse, and a small amount of gravel. The landscape is nearly level to sloping, except along the rivers. Remnants of the drumlin field that are covered with sand are in this area. Menahga, Friendship, Meehan, and Roscommon soils formed in this outwash material.

Another distinct area of outwash is south of the Leaf River, and it extends into Todd County and the southeastern part of Ottertail County. The outwash in this area consists of calcareous sand and gravel washed from the Alexandria moraine and the Henning till plain. The material is dominantly sand and coarse sand and a moderate amount of gravel. Carbonates are leached to a depth of about 4 feet. The landscape is nearly level to sloping. Sand-covered drumlins also are in this area. Dorset, Nymore, Verndale, Oylen, and Forada soils formed in this outwash material.

The organic material in the county consists of herbaceous plant material. Soils that formed in this material have a high water table. Plants such as cattails, sedges, reeds, grasses, and some shrubs thrive on these soils. Because the high water table affects the rate of decomposition, material from these plants accumulates faster than it decomposes. The organic material is 8 inches to more than 7 feet thick, and it dominantly is moderately decomposed to highly decomposed. The organic soils are in depressions, potholes, and broad drainageways throughout the county. Seelyeville, Rifle, Markey, and Cathro soils are examples.

Climate

Wadena County has a cool, subhumid, continental climate characterized by cold winters and hot summers. Rainfall and snowmelt dissolve minerals and support biological activity, and the water moves minerals and organic residue into the soil. Rainfall also helps to leach carbonates into the soil. Temperature influences the



kinds of plants and animals in the soil and their growth rates. Soils that formed in cooler areas support prairie vegetation and generally have greater accumulations of organic matter than those that support forest vegetation. The rates of physical and chemical weathering of soil also are controlled by temperature. Freezing of the soil

in winter slows the soil-forming processes. Alternate freezing and thawing help to develop soil by disintegrating the parent material, and frost heaving helps to mix the soil material.

More information on the climate of the county is given in the section "General Nature of the County."

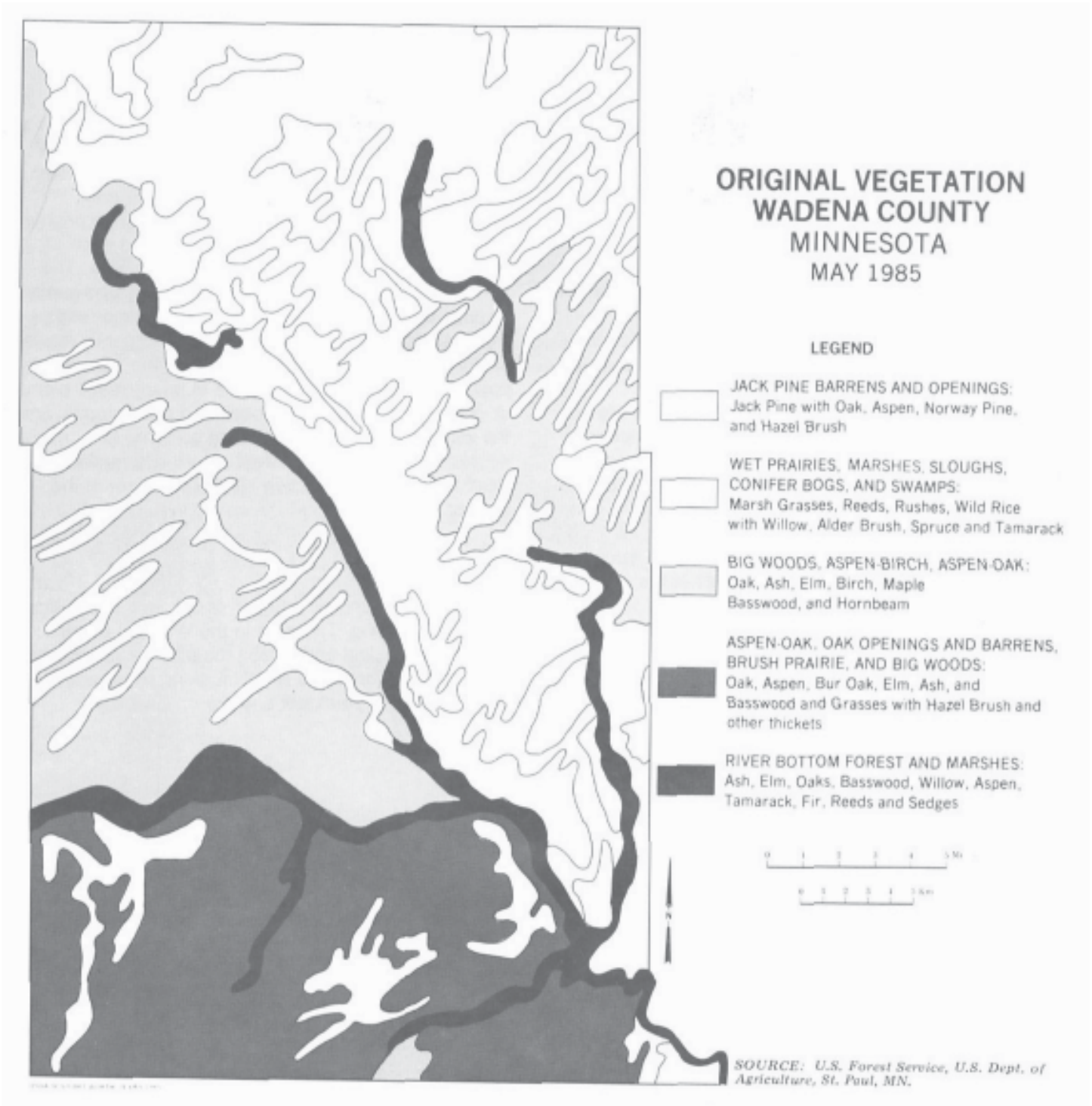


Figure 13.—Original vegetation of Wadena County.

Plant and Animal Life

The native vegetation in Wadena County consists of four major types (fig. 13). The southwestern part of the county supports hardwood trees, grassland openings, and marshes or wet prairies. The most common hardwood trees are oak, aspen, elm, ash, and birch. Reeds, rushes, sedges, willow, and alder are common on the wet prairies and marshes. Small, scattered areas of pine also are present. The northeastern part of the county dominantly has barrens, marshes, and small areas of aspen and birch. The vegetation in the barrens dominantly is jack pine and red pine. Scattered bur oak also is present. Reeds, sedges, cattails, willows, alder, tamarack, and black spruce are common in the marshes. Occasional forest fires help to renew the forest vegetation. Fires open the persistent, closed cones and kill old stands and thus allow jack pine to regenerate *(4)*.

Both plants and animals in and on the soil influence the chemical and biological processes of soil formation, but plants generally have the greatest influence. Bacteria, earthworms, and other forms of animal life aid in the weathering of soil material and the decomposition of organic matter. Earthworms and small burrowing animals help to mix the upper layers of the soil. Plants, including fungi, influence formation by returning decaying plant residue to the soil and aiding in its decomposition. The vegetation also affects the structure of the soil and the movement of nutrients in the soil.

Humans, particularly by altering drainage, maintaining fertility, changing vegetation, and altering runoff and the infiltration rate, have an important effect on soil formation. Farming and land-clearing activities affect some soil-forming processes. If areas of farmland are left unprotected, erosion is accelerated and thus affects the formation of soils.

Relief

Relief is an important factor in soil formation because it affects drainage, aeration, and erosion. Differences in relief can account for the development of different soils in similar parent material. Because relief influences runoff and drainage, it can affect the types of vegetation present and the chemical changes on and in the soil. Excessive runoff reduces the amount of water that is available to leach the soil and for use by plants, and it can increase the risk of erosion.

Topographic position on the landscape affects the drainage class of the soil. For example, the drainage class of the Rockwood, Blowers, Paddock, and Runeberg soils, which make up the Rockwood drainage sequence, generally is predictable because each of these soils is in a particular landscape position. The well drained Rockwood soils are in sloping and gently sloping, convex areas on side slopes; the moderately well drained Blowers soils are in the less gently sloping, convex or plane areas and on hilltops; the somewhat poorly drained Paddock soils are in nearly level, plane or concave areas on foot slopes and head slopes; and the very poorly drained Runeberg soils are in depressions and drainageways. More information on relief is given in the section "General Nature of the County."

Time

In terms of geologic time, all of the soils in Wadena County are young. The soils in the Wadena drumlin field are the oldest and exhibit the most development. The soils that formed in alluvium along rivers and streams are the youngest and are only weakly developed.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Basal till. Compact glacial till deposited beneath the ice.

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Biomass crop. A crop that is grown for its fiber, which is used as a source of energy.

Biomass mat. A layer of black organic matter that forms in areas where effluent has moved from an absorption field trench onto the soil.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles

(flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Congeliturbate. Soil material disturbed by frost action.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard, little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a

short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Drumlin. A low, smooth, elongated oval hill, mound, or ridge of compact glacial till. The longer axis is parallel to the path of the glacier and commonly has a blunt nose pointing in the direction from which the ice approached.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Erosion pavement. A layer of gravel or stones that remains on the surface after fine particles are removed by sheet or rill erosion.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also, the sorted and unsorted material

deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cd horizon.—Dense glacial till beneath the soil. This material cannot be penetrated by roots, and it cannot be dug with a spade.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are

soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Interdrumlin. Nearly level, swalelike areas of drainageways between glacial drumlins.

Irrigation. Application of water to soils to assist in production of crops. The method of irrigation used in this county is a sprinkler system. Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are—

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep-sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil

before reaching surface streams is called groundwater runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silica-sesquioxide ratio. The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. The slope classes used in this survey are as follows:

Nearly level	0 to 2 percent
Gently sloping	2 to 6 percent
Sloping	6 to 12 percent
Moderately steep	12 to 18 percent
Steep	18 to 25 percent
Very steep	25 to 45 percent

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the substratum. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to soil blowing and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Varve. A sedimentary layer of a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

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Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-81 at Wadena, Minnesota)

Month	Temperature						Precipitation				
				2 years in 10 will have--				2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average	Maximum temperature higher than--	Minimum temperature lower than--	Average number of growing degree days*	Average	Less than--	More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January	16.0	-5.4	5.3	43	-34	0	0.81	0.23	1.26	3	10.4
February	23.5	.6	12.1	47	-29	0	.61	.17	.96	2	7.1
March	35.0	13.6	24.3	61	-23	8	1.36	.52	2.05	4	10.6
April	52.7	30.3	41.5	84	7	31	2.47	1.12	3.63	6	5.1
May	67.1	42.5	54.8	89	23	203	2.97	1.42	4.29	7	.4
June	75.7	52.7	64.2	94	37	426	4.41	2.57	6.04	8	.0
July	80.9	57.5	69.2	96	44	595	4.01	2.12	5.67	7	.0
August	79.0	55.2	67.1	95	38	530	3.47	1.40	5.20	6	.0
September	68.2	45.0	56.6	91	26	217	2.43	.85	3.72	6	.0
October	56.9	34.6	45.8	84	15	76	1.88	.50	2.98	4	1.3
November	37.7	20.0	28.9	65	-10	0	1.19	.47	1.79	3	5.0
December	23.0	4.3	13.7	46	-28	0	.88	.35	1.33	3	8.2
Yearly:											
Average	51.3	29.7	40.3	---	---	---	---	---	---	---	---
Extreme	---	---	---	98	-35	---	---	---	---	---	---
Total	---	---	---	---	---	2,086	26.49	21.50	31.23	59	48.1

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-81 at Wadena, Minnesota)

Probability	Temperature		
	24 °F or lower	28 °F or lower	32 °F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 8	May 17	May 25
2 years in 10 later than--	May 3	May 12	May 21
5 years in 10 later than--	Apr. 24	May 3	May 14
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 1	Sept. 17	Sept. 13
2 years in 10 earlier than--	Oct. 7	Sept. 22	Sept. 16
5 years in 10 earlier than--	Oct. 17	Oct. 1	Sept. 22

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-81 at Wadena, Minnesota)

Probability	Daily minimum temperature during growing season		
	Higher than 24 °F	Higher than 28 °F	Higher than 32 °F
	Days	Days	Days
9 years in 10	154	132	114
8 years in 10	161	138	120
5 years in 10	175	150	130
2 years in 10	188	162	141
1 year in 10	196	168	146

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
82B	Redeye loamy sand, 1 to 6 percent slopes	1,150	0.3
82C	Redeye loamy sand, 6 to 12 percent slopes	650	0.2
126	Graycalm loamy sand	780	0.2
139B	Huntersville loamy fine sand, 1 to 6 percent slopes	4,265	1.2
187	Haug muck	1,000	0.3
207A	Nymore loamy sand, 1 to 3 percent slopes	4,985	1.4
207B	Nymore loamy sand, 3 to 6 percent slopes	7,620	2.2
207C	Nymore loamy sand, 6 to 12 percent slopes	2,940	0.8
260	Duelm loamy sand	6,010	1.7
261	Isan loamy sand	5,540	1.6
374B	Rockwood sandy loam, 2 to 6 percent slopes	1,180	0.3
374C	Rockwood sandy loam, 6 to 12 percent slopes	1,870	0.5
374D	Rockwood sandy loam, 12 to 18 percent slopes	280	0.1
375	Forada loam	6,035	1.7
406A	Dorset sandy loam, 1 to 3 percent slopes	3,380	1.0
406B	Dorset sandy loam, 3 to 6 percent slopes	870	0.3
454B	Mahtomedi loamy sand, 1 to 8 percent slopes	460	0.1
458A	Menahga loamy sand, 0 to 2 percent slopes	26,310	7.6
458B	Menahga loamy coarse sand, 2 to 6 percent slopes	15,800	4.5
458C	Menahga loamy sand, 6 to 15 percent slopes	3,280	0.9
458E	Menahga loamy sand, 15 to 45 percent slopes	910	0.3
540	Seelyeville muck	24,170	7.0
541	Rifle mucky peat	1,325	0.4
543	Markey muck	26,990	7.8
544	Cathro muck	4,345	1.3
545	Rondeau muck	250	0.1
567A	Verndale sandy loam, 0 to 2 percent slopes	21,985	6.3
567B	Verndale sandy loam, 2 to 6 percent slopes	5,410	1.6
701	Runeberg mucky loam	7,905	2.3
720B	Blowers sandy loam, 1 to 5 percent slopes	29,665	8.5
793	Paddock complex	16,750	4.8
834	Friendship-Meehan loamy sands	39,940	11.4
1010	Riverwash	75	*
1015	Psamments, nearly level	440	0.1
1030	Udorthents-Pits complex	280	0.1
1941	Evart loam, frequently flooded	920	0.3
1942	Forada mucky loam, depressional	5,750	1.7
1943	Roscommon loamy sand	23,635	6.8
1956	Staples loamy sand	2,050	0.6
1957B	Friendship loamy sand, till substratum, 1 to 6 percent slopes	6,565	1.9
1968	Evart loam, occasionally flooded	1,195	0.3
1969	Evart-Isan complex, channeled	4,345	1.3
1970B	Menahga loamy sand, till substratum, 1 to 8 percent slopes	2,210	0.6
1975	Oylen sandy loam	7,385	2.1
1984	Leafriver muck	13,420	3.9
1985	Fordum silt loam, occasionally flooded	1,230	0.4
	Water	4,050	1.2
	Total	347,600	100.0

* Less than 0.05 percent.

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
374B	Rockwood sandy loam, 2 to 6 percent slopes
375	Forada loam (where drained)
406A	Dorset sandy loam, 1 to 3 percent slopes
406B	Dorset sandy loam, 3 to 6 percent slopes
567A	Verndale sandy loam, 0 to 2 percent slopes
567B	Verndale sandy loam, 2 to 6 percent slopes
720B	Blowers sandy loam, 1 to 5 percent slopes
1975	Oylen sandy loam

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF NONIRRIGATED CROPS AND PASTURE

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability	Corn	Corn silage	Oats	Barley	Grass-legume hay	Bromegrass-alfalfa
		Bu	Tons	Bu	Bu	Tons	AUM*
82B---------- Redeye	IIIs	70	13	50	45	3.0	5.0
82C---------- Redeye	IIIe	60	12	50	45	3.0	5.0
126---------- Graycalm	IVs	30	9	30	20	2.0	3.0
139B---------- Huntersville	IIIs	70	13	60	55	3.0	5.0
187---------- Haug	VIw	---	---	---	---	---	---
207A---------- Nymore	IVs	50	9	40	30	3.0	5.5
207B---------- Nymore	IVs	45	8	35	25	2.7	5.0
207C---------- Nymore	IVs	35	8	30	20	2.0	3.0
260---------- Duelm	IVs	60	12	50	45	3.5	5.5
261---------- Isan	IVw	60	12	50	45	2.5	4.8
374B---------- Rockwood	IIe	95	14	85	80	4.0	6.0
374C---------- Rockwood	IIIe	75	13	60	55	3.7	6.0
374D---------- Rockwood	IVe	---	---	---	---	---	---
375---------- Forada	IIw	65	12	50	45	3.0	5.5
406A---------- Dorset	IIIs	70	14	50	45	3.5	6.0
406B---------- Dorset	IIIs	60	13	50	40	3.0	5.5
454B---------- Mahtomedi	IVs	25	6	40	---	2.1	3.0
458A, 458B------ Menahga	IVs	25	6	25	---	1.5	2.5
458C---------- Menahga	IVs	---	---	15	---	1.5	2.5

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF NONIRRIGATED CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Corn silage	Oats	Barley	Grass-legume hay	Bromegrass-alfalfa
		Bu	Tons	Bu	Bu	Tons	AUM*
458E---------- Menahga	VIIs	---	---	---	---	---	---
540---------- Seelyeville	VIw	---	---	---	---	---	---
541---------- Rifle	VIw	---	---	---	---	---	---
543---------- Markey	VIw	---	---	---	---	---	---
544---------- Cathro	VIw	---	---	---	---	---	---
545---------- Rondeau	VIw	---	---	---	---	---	---
567A---------- Verndale	IIIs	70	13	50	45	3.5	6.0
567B---------- Verndale	IIIs	65	12	45	40	3.0	5.2
701---------- Runeberg	VIw	---	---	---	---	---	---
720B---------- Blowers	IIe	85	14	85	80	4.0	6.0
793:							
Paddock, very stony---------	VIs	---	---	---	---	---	---
Paddock--------	IIw	75	13	---	80	3.5	6.0
834:							
Friendship-----	IVs	45	9	40	30	2.5	5.0
Meehan---------	IVw	45	9	40	30	2.5	5.0
1010**. Riverwash							
1015**. Psamments							
1030**: Udorthents.							
Pits.							
1941---------- Evart	VIIw	---	---	---	---	---	---
1942---------- Forada	VIw	---	---	---	---	---	---
1943---------- Roscommon	IVw	25	6	45	35	2.5	5.0

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF NONIRRIGATED CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Corn silage	Oats	Barley	Grass-legume hay	Bromegrass-alfalfa
		Bu	Tons	Bu	Bu	Tons	AUM*
1956---------- Staples	IIIw	60	12	50	40	2.5	5.0
1957B---------- Friendship	IIIs	60	12	60	50	3.0	5.2
1968---------- Evart	IVw	60	12	---	---	2.5	4.8
1969:							
Evart----------	VIIw	---	---	---	---	---	---
Isan----------	IVw	---	---	---	---	---	---
1970B---------- Menahga	IVs	50	9	40	35	2.5	5.0
1975---------- Oylen	IIIs	70	13	50	45	3.5	6.0
1984---------- Leafriver	VIw	---	---	---	---	---	---
1985---------- Fordum	IVw	65	12	---	---	3.0	5.5

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

(Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available)

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume	
82B, 82C-------- Redeye	6S	Slight	Moderate	Moderate	Slight	Quaking aspen------- Red pine---------- Jack pine---------- Bur oak---------- Bigtooth aspen------ Northern red oak---- Eastern white pine--	78 67 61 --- 75 45 55	91 93 87 --- 91 --- ---	Red pine, white spruce, eastern white pine, jack pine.
126---------- Graycalm	6A	Slight	Slight	Slight	Slight	Jack pine---------- Red pine---------- Quaking aspen-------	59 61 65	82 84 64	Red pine, eastern white pine, jack pine.
139B---------- Huntersville	6L	Slight	Severe	Slight	Slight	Quaking aspen------- Red pine---------- Jack pine---------- Bigtooth aspen------ Northern red oak---- Bur oak---------- Eastern white pine--	77 55 61 75 --- --- ---	90 --- 87 90 --- --- ---	Red pine, white spruce, eastern white pine, jack pine.
207A, 207B, 207C---------- Nymore	6S	Slight	Slight	Moderate	Slight	Jack pine---------- Red pine---------- Eastern white pine--	58 55 61	82 88 ---	Red pine, white spruce, jack pine.
260---------- Duelm	6W	Slight	Moderate	Slight	Moderate	Jack pine---------- Eastern white pine-- Quaking aspen------- Red pine----------	60 61 68 60	94 --- 78 101	Eastern white pine, red pine, white spruce, jack pine.
374B, 374C------ Rockwood	4L	Slight	Moderate	Slight	Slight	Northern red oak---- Quaking aspen------- White oak---------- Bur oak----------	61 65 52 54	53 84 37 38	Red pine, eastern white pine, jack pine, northern red oak, green ash.
374D---------- Rockwood	4R	Moderate	Moderate	Slight	Slight	Northern red oak---- Quaking aspen------- White oak---------- Bur oak----------	61 65 52 54	53 84 37 38	Red pine, eastern white pine, jack pine, northern red oak, green ash.
406A, 406B------ Dorset	2A	Slight	Slight	Slight	Slight	Bur oak---------- Northern red oak---- Quaking aspen------- Green ash---------- Jack pine----------	45 50 60 50 58	--- --- --- --- ---	Eastern white pine, white spruce, red pine.

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume	
454B---------- Mahtomedi	6S	Slight	Moderate	Moderate	Slight	Jack pine----------	60	85	Red pine, jack pine, eastern white pine.
						Red pine----------	55	88	
						Bigtooth aspen------	77	---	
						Northern red oak----	48	---	
						Quaking aspen-------	60	64	
458A, 458B, 458C---------- Menahga	6S	Slight	Moderate	Moderate	Slight	Jack pine----------	59	84	Red pine, jack pine.
						Red pine----------	53	82	
						Quaking aspen-------	60	64	
						Bigtooth aspen------	76	---	
458E---------- Menahga	6R	Moderate	Moderate	Moderate	Slight	Jack pine----------	59	84	Red pine, jack pine.
						Red pine----------	53	82	
						Quaking aspen-------	60	64	
						Bigtooth aspen------	76	---	
541---------- Rifle	3W	Slight	Severe	Severe	Severe	Black spruce--------	35	46	Black spruce, tamarack, balsam fir.
						Tamarack----------	60	---	
						Balsam fir----------	45	---	
701---------- Runeberg	6W	Slight	Severe	Severe	Severe	Quaking aspen-------	79	93	Black ash, black spruce, green ash, white spruce.
						Black ash----------	61	44	
						Green ash----------	64	57	
720B---------- Blowers	6L	Slight	Severe	Slight	Slight	Quaking aspen-------	72	84	Red pine, white spruce, eastern white pine, northern red oak, green ash, jack pine, white oak.
						Northern red oak----	65	59	
						American basswood---	75	73	
						Red pine----------	67	120	
						White oak----------	55	42	
						American elm--------	55	---	
						Jack pine----------	70	---	
						White spruce--------	52	---	
793*: Paddock, very stony---------	4X	Slight	Severe	Slight	Moderate	Northern red oak----	60	51	White spruce, green ash, northern red oak, eastern white pine, white oak.
						Quaking aspen-------	72	84	
						Black ash----------	66	48	
						White oak----------	57	46	
						White spruce--------	45	84	
						Green ash----------	66	59	
						American elm--------	---	---	
Paddock--------	4W	Slight	Severe	Slight	Moderate	Northern red oak----	60	51	White spruce, green ash, northern red oak, red pine.
						Quaking aspen-------	72	84	
						White spruce--------	45	84	
						Black ash----------	66	48	
						American elm--------	50	---	
						White oak----------	57	46	
						Green ash----------	66	59	
834*: Friendship-----	7S	Slight	Moderate	Moderate	Slight	Jack pine----------	68	100	Red pine, eastern white pine, jack pine, white spruce.
						Red pine----------	60	101	
						Quaking aspen-------	68	78	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume	
834*:									
Meehan	6W	Slight	Moderate	Slight	Moderate	Jack pine	66	100	Eastern white pine, jack pine, white spruce, balsam fir, red pine.
						Red pine	60	101	
						Quaking aspen	70	78	
1941 Evart	2W	Slight	Severe	Severe	Severe	Quaking aspen	45	91	Northern whitecedar, black ash, balsam fir.
						Balsam fir	---	---	
						American basswood	57	46	
						Black ash	---	---	
1943 Roscommon	6W	Slight	Severe	Moderate	Severe	Quaking aspen	76	91	White spruce, black spruce, balsam fir, northern whitecedar, jack pine, black ash.
						Jack pine	60	---	
						Balsam fir	---	---	
1956 Staples	6W	Slight	Severe	Moderate	Severe	Quaking aspen	71	87	White spruce, black ash, jack pine, black spruce, northern whitecedar, balsam fir, eastern white pine, green ash.
						Black ash	65	48	
						Jack pine	---	---	
						Northern red oak	---	---	
						White oak	---	---	
						American elm	---	---	
1957B Friendship	6S	Slight	Moderate	Moderate	Slight	Jack pine	61	87	Red pine, northern red oak, eastern white pine, jack pine, white spruce.
						Red pine	57	93	
						Quaking aspen	65	73	
1968 Evart	7W	Slight	Severe	Severe	Severe	Quaking aspen	78	91	Northern whitecedar, black spruce, balsam fir, American basswood, white oak, northern red oak.
						Balsam fir	40	---	
						American basswood	57	46	
						Black ash	---	---	
						American elm	---	---	
1969*:									
Evart	7W	Slight	Severe	Severe	Severe	Quaking aspen	78	91	Northern whitecedar, black spruce, balsam fir, black ash.
						Balsam fir	40	5	
						American basswood	57	46	
						Black ash	---	---	
						American elm	---	---	
Isan.									

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume	
1970B---------- Menahga	6S	Slight	Slight	Moderate	Slight	Jack pine----------	60	87	Red pine, jack pine, white spruce, eastern white pine, northern red oak.
						Red pine----------	55	93	
						Quaking aspen-------	70	73	
						Bur oak----------	40	---	
1985---------- Fordum	6W	Slight	Severe	Severe	Severe	Quaking aspen-------	78	91	Black spruce, northern whitecedar, balsam fir, black ash, white oak, northern red oak.
						Black ash----------	---	---	
						American elm--------	---	---	
						White oak----------	---	---	
						American basswood---	57	---	

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil. Only the soils suited to windbreaks and environmental plantings are listed)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
82B, 82C---------- Redeye	Silver buffaloberry.	Russian olive, Amur maple, lilac, Siberian peashrub, common chokecherry, American plum, red splendor crabapple.	White spruce, red pine, blue spruce, hackberry.	Green ash, jack pine, eastern white pine.	---
126---------- Graycalm	---	Lilac, Siberian peashrub, Manchurian crabapple, Russian olive.	Jack pine, red pine, green ash, Scotch pine, white spruce.	---	---
139B---------- Huntersville	Silver buffaloberry.	Amur maple, lilac, Siberian peashrub, common chokecherry, American plum, Russian olive, red splendor crabapple.	White spruce, blue spruce, hackberry.	Eastern white pine, green ash, red pine, jack pine.	---
207A, 207B, 207C-- Nymore	Silver buffaloberry.	Lilac, Siberian peashrub, red splendor crabapple.	Jack pine, red pine, green ash, Scotch pine, white spruce.	---	---
260---------- Duelm	Silver buffaloberry.	Siberian peashrub, American plum, red splendor crabapple, lilac, Russian olive, Nanking cherry, common chokecherry, Amur maple.	White spruce, blue spruce, red pine, eastern white pine, Scotch pine, green ash.	Green ash, eastern white pine, red pine.	Carolina poplar, northwest poplar.
261---------- Isan	Silver buffaloberry.	American plum, lilac, Siberian peashrub, American cranberrybush, redosier dogwood, Amur maple, common chokecherry, red splendor crabapple, Juneberry.	White spruce, blue spruce, Norway spruce.	Green ash.	Carolina poplar.
374B, 374C, 374D-- Rockwood	---	Amur maple, lilac, Siberian peashrub, common chokecherry.	Scotch pine, white spruce, Manchurian crabapple, blue spruce.	Red pine, green ash, eastern white pine, sugar maple, hackberry.	---

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
375---------- Forada	Silver buffaloberry.	Lilac, Siberian peashrub, American cranberrybush, redosier dogwood, Amur maple, red splendor crabapple, common chokecherry, Juneberry.	White spruce, blue spruce, Norway spruce, hackberry, Scotch pine.	Green ash.	Carolina poplar.
406A, 406B-------- Dorset	Silver buffaloberry, Siberian peashrub.	Nanking cherry, Russian olive, lilac, common chokecherry, Manchurian crabapple.	Eastern white pine, red pine, green ash, hackberry, blue spruce, white spruce.	---	Northwest poplar, Carolina poplar.
454B---------- Mahtomedi	Silver buffaloberry.	Red splendor crabapple.	---	---	---
458A, 458B, 458C, 458E---------- Menahga	Silver buffaloberry.	American plum, Amur maple, lilac, Siberian peashrub.	Red pine, jack pine, green ash, white spruce, Scotch pine.	---	---
540---------- Seelyeville	---	Amur maple--------	---	---	---
567A, 567B-------- Verndale	Silver buffaloberry.	Nanking cherry, Amur maple, Juneberry, lilac, Siberian peashrub.	Red pine, white spruce, eastern white pine, green ash, blue spruce, hackberry.	---	Carolina poplar, northwest poplar.
701---------- Runeberg	---	Common chokecherry, American plum, red splendor crabapple, Russian olive.	---	---	---
720B---------- Blowers	Silver buffaloberry.	Amur maple, lilac, Siberian peashrub, American plum.	White spruce, Russian olive, Manchurian crabapple, red splendor crabapple, blue spruce.	Green ash, eastern white pine, red pine, sugar maple, hackberry.	Northwest poplar.
793*: Paddock, very stony----------	---	Redosier dogwood, Juneberry, common chokecherry.	Norway spruce-----	---	---

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
793*:					
Paddock	Silver buffaloberry.	Redosier dogwood, American plum, lilac, Siberian peashrub, common chokecherry, Juneberry.	Black spruce, Norway spruce, white spruce, blue spruce, Manchurian crabapple.	Eastern white pine, jack pine, green ash, red pine, hackberry.	---
834*:					
Friendship	Silver buffaloberry.	Lilac, Siberian peashrub.	Green ash, Norway spruce, white spruce, blue spruce, Scotch pine, red pine, jack pine, eastern white pine.	---	---
Meehan	---	Lilac, Siberian peashrub, redosier dogwood.	Blue spruce, white spruce, eastern white pine, red pine, jack pine, Norway spruce, green ash.	---	---
1943 Roscommon	Silver buffaloberry.	Nannyberry viburnum, silky dogwood, lilac, redosier dogwood, Siberian peashrub, Amur maple, American plum.	White spruce, black spruce, Norway spruce, jack pine, eastern white pine, green ash.	---	Carolina poplar.
1956 Staples	Silver buffaloberry.	Redosier dogwood, lilac, Siberian peashrub, nannyberry viburnum, Amur maple, silky dogwood, American maple.	Black spruce, jack pine, Norway spruce, white spruce, eastern white pine, green ash.	---	Carolina poplar.
1957B Friendship	Silver buffaloberry.	Lilac, Siberian peashrub, Amur maple, redosier dogwood, American plum, common chokecherry, red splendor crabapple.	Green ash, jack pine, red pine, white spruce, blue spruce, hackberry, Siberian elm, eastern white pine.	---	Northwest poplar.
1970B Menahga	Silver buffaloberry.	Amur maple, lilac, Siberian peashrub, silky dogwood, gray dogwood, American plum, common chokecherry.	Scotch pine, white spruce, green ash, blue spruce, hackberry, jack pine, red pine, eastern white pine.	---	Northwest poplar.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1975---------- Oylen	Silver buffaloberry.	Lilac, Siberian peashrub, American plum, red splendor crabapple, Russian olive, Nanking cherry, common chokecherry, Amur maple.	Blue spruce, white spruce, Scotch pine, red pine, green ash, eastern white pine.	---	Carolina poplar, northwest poplar.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
82B Redeye	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.
82C Redeye	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Moderate: droughty, slope.
126 Graycalm	Moderate: too sandy.	Moderate: too sandy.	Moderate: small stones, too sandy.	Moderate: too sandy.	Severe: droughty.
139B Huntersville	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
187 Haug	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
207A, 207B Nymore	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Severe: droughty.
207C Nymore	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Severe: droughty.
260 Duelm	Moderate: wetness.	Moderate: wetness.	Moderate: small stones, wetness.	Slight	Moderate: droughty.
261 Isan	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
374B Rockwood	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: large stones.
374C Rockwood	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: large stones, slope.
374D Rockwood	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
375 Forada	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
406A, 406B Dorset	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
454B Mahtomedi	Moderate: small stones.	Moderate: too sandy.	Severe: small stones.	Moderate: too sandy.	Moderate: small stones.
458A Menahga	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: droughty.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
458B Menahga	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.
458C Menahga	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Moderate: slope, droughty.
458E Menahga	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
540 Seelyeville	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
541 Rifle	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
543 Markey	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
544 Cathro	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
545 Rondeau	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
567A Verndale	Slight	Slight	Moderate: small stones.	Slight	Moderate: droughty.
567B Verndale	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
701 Runeberg	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
720B Blowers	Moderate: wetness.	Moderate: wetness.	Moderate: slope, small stones, wetness.	Slight	Moderate: large stones.
793*: Paddock, very stony	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: large stones, wetness.
Paddock	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
834*: Friendship	Moderate: too sandy.	Moderate: too sandy.	Moderate: small stones, too sandy.	Moderate: too sandy.	Moderate: droughty.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
834*: Meehan	Severe: wetness.	Moderate: wetness, too sandy.	Severe: wetness.	Moderate: wetness, too sandy.	Moderate: wetness, droughty.
1010*. Riverwash					
1015*. Psamments					
1030*: Udorthents.					
Pits.					
1941--- Evart	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.
1942--- Forada	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1943--- Roscommon	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
1956--- Staples	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
1957B--- Friendship	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, small stones, too sandy.	Moderate: too sandy.	Moderate: droughty.
1968--- Evart	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
1969*: Evart	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.
Isan	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
1970B--- Menahga	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, small stones, too sandy.	Moderate: too sandy.	Moderate: droughty.
1975--- Oylen	Moderate: wetness.	Moderate: wetness.	Moderate: small stones, wetness.	Slight---	Moderate: droughty.
1984--- Leafriver	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1985---------- Fordum	Severe: flooding, wetness.	Severe: wetness.	Severe----------	Severe: wetness.	Severe.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements						
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas
82B, 82C---------- Redeye	Fair	Good	Good	Good	Good	Very poor	Very poor.
126---------- Graycalm	Poor	Poor	Fair	Good	Good	Very poor	Very poor.
139B---------- Huntersville	Good	Good	Good	Good	Good	Poor	Very poor.
187---------- Haug	Very poor	Very poor	Poor	Poor	Poor	Good	Good.
207A, 207B, 207C--- Nymore	Poor	Fair	Fair	Poor	Fair	Very poor	Very poor.
260---------- Duelm	Fair	Fair	Good	Fair	Good	Fair	Fair.
261---------- Isan	Fair	Fair	Poor	Fair	Poor	Good	Good.
374B---------- Rockwood	Good	Good	Good	Good	Good	Poor	Very poor.
374C---------- Rockwood	Fair	Good	Good	Good	Good	Very poor	Very poor.
374D---------- Rockwood	Poor	Fair	Good	Good	Good	Very poor	Very poor.
375---------- Forada	Fair	Fair	Good	Fair	Poor	Good	Good.
406A, 406B--------- Dorset	Good	Good	Fair	Fair	Fair	Very poor	Very poor.
454B---------- Mahtomedi	Poor	Poor	Fair	Poor	Fair	Very poor	Very poor.
458A, 458B, 458C--- Menahga	Poor	Poor	Fair	Poor	Fair	Very poor	Very poor.
458E---------- Menahga	Very poor	Poor	Fair	Poor	Fair	Very poor	Very poor.
540---------- Seelyeville	Very poor	Very poor	Very poor	Very poor	Poor	Good	Good.
541---------- Rifle	Very poor	Very poor	Very poor	Very poor	Poor	Good	Good.
543---------- Markey	Very poor	Very poor	Poor	Very poor	Very poor	Good	Good.
544---------- Cathro	Very poor	Very poor	Poor	Very poor	Very poor	Good	Good.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas
545---------- Rondeau	Very poor	Very poor	Poor	Very poor	Very poor	Good	Good.
567A, 567B---------- Verndale	Good	Good	Fair	Fair	Fair	Poor	Very poor.
701---------- Runeberg	Very poor	Poor	Fair	Fair	Poor	Good	Good.
720B---------- Blowers	Good	Good	Good	Good	Good	Poor	Very poor.
793*:							
Paddock, very stony----------	Very poor	Poor	Good	Good	Good	Fair	Fair.
Paddock----------	Good	Good	Good	Good	Good	Fair	Fair.
834*:							
Friendship--------	Poor	Fair	Good	Fair	Good	Poor	Very poor.
Meehan----------	Poor	Fair	Good	Good	Poor	Fair	Fair.
1010*. Riverwash							
1015*. Psamments							
1030*:							
Udorthents.							
Pits.							
1941---------- Evart	Very poor	Poor	Fair	Good	Fair	Good	Good.
1942---------- Forada	Very poor	Poor	Fair	Poor	Poor	Good	Good.
1943---------- Roscommon	Poor	Poor	Fair	Good	Fair	Fair	Good.
1956---------- Staples	Poor	Fair	Fair	Good	Fair	Fair	Good.
1957B---------- Friendship	Fair	Fair	Good	Fair	Good	Poor	Very poor.
1968---------- Evart	Poor	Poor	Good	Good	Fair	Fair	Good.
1969*:							
Evart----------	Very poor	Poor	Poor	Poor	Poor	Good	Good.
Isan----------	Poor	Poor	Fair	Fair	Poor	Fair	Good.
1970B---------- Menahga	Fair	Fair	Fair	Fair	Good	Very poor	Very poor.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas
1975 Oylen	Good	Good	Good	Fair	Fair	Fair	Fair.
1984 Leafriver	Very poor	Very poor	Fair	Poor	Poor	Good	Good.
1985 Fordum	Poor	Poor	Good	Good	Fair	Fair	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
82B Redeye	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: frost action.	Moderate: droughty.
82C Redeye	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: droughty, slope.
126 Graycalm	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Severe: droughty.
139B Huntersville	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Severe: frost action.	Moderate: droughty.
187 Haug	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding, excess humus.
207A Nymore	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Severe: droughty.
207B Nymore	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.
207C Nymore	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
260 Duelm	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Moderate: droughty.
261 Isan	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
374B Rockwood	Moderate: dense layer.	Slight	Slight	Moderate: slope.	Moderate: frost action.	Moderate: large stones.
374C Rockwood	Moderate: dense layer, slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: large stones, slope.
374D Rockwood	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
375 Forada	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
406A Dorset	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
406B Dorset	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
454B Mahtomedi	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: small stones.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
458A--- Menahga	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
458B--- Menahga	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
458C--- Menahga	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope, droughty.
458E--- Menahga	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
540--- Seelyeville	Severe: excess humus, ponding.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, excess humus.
541--- Rifle	Severe: excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
543--- Markey	Severe: cutbanks cave, excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
544--- Cathro	Severe: excess humus, ponding.	Severe: subsides, ponding.	Severe: subsides, ponding.	Severe: subsides, ponding.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
545--- Rondeau	Severe: excess humus, ponding.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, excess humus.
567A--- Verndale	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
567B--- Verndale	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
701--- Runeberg	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
720B--- Blowers	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Moderate: large stones.
793*:						
Paddock, very stony---	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: large stones, wetness.
Paddock---	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
834*:						
Friendship	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Slight	Moderate: droughty.
Meehan	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.	Moderate: wetness, droughty.
1010*. Riverwash						
1015*. Psamments						
1030*: Udorthents.						
Pits.						
1941 Evart	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding.	Severe: wetness, flooding.
1942 Forada	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
1943 Roscommon	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
1956 Staples	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.
1957B Friendship	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Slight	Moderate: droughty.
1968 Evart	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding.	Severe: wetness.
1969*: Evart	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding.	Severe: wetness, flooding.
Isan	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
1970B Menahga	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
1975 Oylen	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Moderate: droughty.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1984--Leafriver	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding, excess humus.
1985--Fordum	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding, frost action.	Severe.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
82B Redeye	Severe: percs slowly, poor filter.	Severe: seepage.	Severe: too sandy.	Severe: seepage.	Poor: seepage, too sandy.
82C Redeye	Severe: percs slowly, poor filter.	Severe: seepage, slope.	Severe: too sandy.	Severe: seepage.	Poor: seepage, too sandy.
126 Graycalm	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
139B Huntersville	Severe: wetness, percs slowly.	Severe: seepage.	Moderate: wetness, too sandy.	Severe: seepage.	Fair: too sandy, small stones, wetness.
187 Haug	Severe: ponding.	Severe: seepage, excess humus, ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
207A, 207B Nymore	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
207C Nymore	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
260 Duelm	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
261 Isan	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
374B Rockwood	Severe: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
374C Rockwood	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
374D Rockwood	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
375 Forada	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
406A, 406B---------- Dorset	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
454B---------- Mahtomedi	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
458A, 458B---------- Menahga	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
458C---------- Menahga	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
458E---------- Menahga	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
540---------- Seelyeville	Severe: ponding, subsides.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: ponding, excess humus.
541---------- Rifle	Severe: subsides, ponding.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
543---------- Markey	Severe: subsides, ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
544---------- Cathro	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
545---------- Rondeau	Severe: ponding, subsides.	Severe: seepage, excess humus.	Severe: ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
567A, 567B---------- Verndale	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
701---------- Runeberg	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
720B---------- Blowers	Severe: wetness, percs slowly.	Moderate: seepage, slope.	Moderate: wetness.	Moderate: wetness.	Fair: small stones, wetness.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
793*:					
Paddock, very stony	Severe: wetness, percs slowly.	Moderate: seepage.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Paddock	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
834*:					
Friendship	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
Meehan	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
1010*. Riverwash					
1015*. Psamments					
1030*: Udorthents.					
Pits.					
1941 Evart	Severe: flooding, wetness, poor filter.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: seepage, too sandy, wetness.
1942 Forada	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
1943 Roscommon	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
1956 Staples	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
1957B Friendship	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: too sandy.	Severe: seepage.	Poor: seepage, too sandy.
1968 Evart	Severe: flooding, wetness, poor filter.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: seepage, too sandy, wetness.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1969*:					
Evart	Severe: flooding, wetness, poor filter.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: seepage, too sandy, wetness.
Isan	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
1970B	Severe: percs slowly, poor filter.	Severe: seepage.	Severe: too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Menahga					
1975	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
Oylen					
1984	Severe: ponding, poor filter.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
Leafriver					
1985	Severe: flooding, wetness.	Severe: seepage, flooding.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: seepage, too sandy, wetness.
Fordum					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
82B, 82C Redeye	Good	Improbable: thin layer.	Improbable: too sandy.	Fair: too sandy, small stones.
126 Graycalm	Good	Probable	Improbable: too sandy.	Poor: too sandy.
139B Huntersville	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
187 Haug	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
207A, 207B, 207C Nymore	Good	Probable	Improbable: too sandy.	Poor: too sandy.
260 Duelm	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
261 Isan	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, wetness.
374B Rockwood	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim.
374C Rockwood	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim, slope.
374D Rockwood	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
375 Forada	Fair: wetness.	Probable	Probable	Poor: small stones.
406A, 406B Dorset	Good	Probable	Probable	Poor: small stones, area reclaim.
454B Mahtomedi	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
458A, 458B, 458C Menahga	Good	Probable	Improbable: too sandy.	Poor: too sandy.
458E Menahga	Poor: slope.	Probable	Improbable: too sandy.	Poor: slope, too sandy.
540 Seelyeville	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
541--Rifle	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.
543--Markey	Poor: wetness.	Probable	Improbable: too sandy.	Poor: excess humus, wetness.
544--Cathro	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
545--Rondeau	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.
567A, 567B--Verndale	Good	Probable	Improbable: too sandy.	Poor: too sandy.
701--Runeberg	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, wetness.
720B--Blowers	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim.
793*:				
Paddock, very stony	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Paddock	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim.
834*:				
Friendship	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
Meehan	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
1010*. Riverwash				
1015*. Psamments				
1030*:				
Udorthents.				
Pits.				
1941--Evart	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, small stones, wetness.
1942--Forada	Poor: wetness.	Probable	Probable	Poor: small stones, wetness.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1943---------- Roscommon	Poor: wetness.	Probable----------	Improbable: too sandy.	Poor: too sandy, wetness.
1956---------- Staples	Poor: wetness.	Improbable: thin layer.	Improbable: too sandy.	Poor: small stones, wetness, too sandy.
1957B---------- Friendship	Good----------	Improbable: thin layer.	Improbable: too sandy.	Poor: too sandy.
1968---------- Evart	Poor: wetness.	Probable----------	Improbable: too sandy.	Poor: too sandy, small stones, wetness.
1969*: Evart----------	Poor: wetness.	Probable----------	Improbable: too sandy.	Poor: too sandy, small stones, wetness.
Isan----------	Poor: wetness.	Probable----------	Improbable: too sandy.	Poor: too sandy, wetness.
1970B---------- Menahga	Good----------	Probable----------	Improbable: too sandy.	Poor: too sandy, small stones.
1975---------- Oylen	Fair: wetness.	Probable----------	Improbable: too sandy.	Poor: too sandy.
1984---------- Leafriver	Poor: wetness.	Probable----------	Improbable: too sandy.	Poor: too sandy, wetness.
1985---------- Fordum	Poor: wetness.	Probable----------	Improbable: too sandy.	Poor: small stones, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
82B---------- Redeye	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
82C---------- Redeye	Severe: seepage, slope.	Severe: seepage.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
126---------- Graycalm	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake.	Too sandy, soil blowing.	Droughty.
139B---------- Huntersville	Severe: seepage.	Severe: seepage, piping.	Frost action, slope, cutbanks cave.	Slope, wetness, droughty.	Wetness, too sandy, soil blowing.	Droughty, rooting depth.
187---------- Haug	Moderate: seepage.	Severe: piping, ponding.	Ponding, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
207A---------- Nymore	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake.	Too sandy, soil blowing.	Droughty.
207B---------- Nymore	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
207C---------- Nymore	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
260---------- Duelm	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Droughty.
261---------- Isan	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Wetness, droughty.
374B---------- Rockwood	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope, soil blowing, percs slowly.	Soil blowing---	Rooting depth.
374C, 374D-------- Rockwood	Severe: slope.	Severe: piping.	Deep to water	Slope, soil blowing, percs slowly.	Slope, soil blowing.	Slope, rooting depth.
375---------- Forada	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	Wetness.
406A---------- Dorset	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
406B---------- Dorset	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
454B---------- Mahtomedi	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty, rooting depth.
458A---------- Menahga	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
458B---------- Menahga	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
458C, 458E-------- Menahga	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
540---------- Seelyeville	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides.	Ponding--------	Ponding--------	Wetness.
541---------- Rifle	Severe: seepage.	Severe: excess humus, ponding.	Ponding, frost action.	Ponding--------	Ponding--------	Wetness.
543---------- Markey	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, too sandy, soil blowing.	Wetness.
544---------- Cathro	Severe: seepage.	Severe: piping, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
545---------- Rondeau	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides.	Ponding, soil blowing, percs slowly.	Ponding, soil blowing.	Wetness.
567A---------- Verndale	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
567B---------- Verndale	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
701---------- Runeberg	Slight-------	Severe: piping, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, rooting depth, percs slowly.
720B---------- Blowers	Moderate: seepage, slope.	Severe: piping.	Frost action, slope.	Slope, wetness, soil blowing.	Wetness, soil blowing, percs slowly.	Rooting depth.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
793*: Paddock, very stony	Slight	Severe: piping.	Percs slowly, frost action.	Wetness, percs slowly, rooting depth.	Wetness	Wetness, rooting depth, percs slowly.
Paddock	Moderate: seepage.	Severe: piping.	Frost action	Wetness, percs slowly.	Wetness	Wetness, rooting depth.
834*: Friendship	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Droughty.
Meehan	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Wetness, droughty.
1010*. Riverwash						
1015*. Psamments						
1030*: Udorthents.						
Pits.						
1941 Evart	Severe: seepage.	Severe: seepage, piping, wetness.	Flooding, cutbanks cave.	Wetness, droughty.	Wetness, too sandy.	Wetness, droughty.
1942 Forada	Severe: seepage.	Severe: seepage, ponding.	Ponding, frost action, cutbanks cave.	Ponding	Ponding, too sandy.	Wetness.
1943 Roscommon	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Wetness, droughty.
1956 Staples	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness, droughty, fast intake.	Large stones, wetness, too sandy.	Large stones, wetness, droughty.
1957B Friendship	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
1968 Evart	Severe: seepage.	Severe: seepage, piping, wetness.	Flooding, cutbanks cave.	Wetness, droughty.	Wetness, too sandy.	Wetness, droughty.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
1969*:						
Evart	Severe: seepage.	Severe: seepage, piping, wetness.	Flooding, cutbanks cave.	Wetness, droughty.	Wetness, too sandy.	Wetness, droughty.
Isan	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty.	Wetness, too sandy, soil blowing.	Wetness, droughty.
1970B---------- Menahga	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
1975---------- Oylen	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, droughty, soil blowing.	Wetness, too sandy, soil blowing.	Droughty.
1984---------- Leafriver	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, too sandy, soil blowing.	Wetness.
1985---------- Fordum	Severe: seepage.	Severe: seepage, piping, wetness.	Flooding, frost action, cutbanks cave.	Wetness, droughty, flooding.	Wetness, too sandy.	Wetness, droughty.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
82B, 82C	0-3	Loamy sand	SM, SP-SM	A-2-4	0	90-100	80-95	65-80	10-30	<20	NP-4
Redeye	3-18	Loamy sand, loamy fine sand, sand.	SM	A-2-4	0	90-100	80-95	65-80	15-30	<20	NP-4
	18-26	Loamy sand, sand	SM, SP-SM	A-2-4, A-3, A-1-b	0-10	85-95	80-90	30-65	5-15	<20	NP-4
	26-52	Sandy loam	SM, SC, SM-SC	A-2-4, A-2-6, A-1-b	0-10	85-100	80-95	45-70	15-35	<25	NP-12
	52-60	Sandy loam	SM, SC, SM-SC	A-2-4, A-1-b	0-10	85-100	80-95	45-70	15-35	<25	NP-9
126	0-9	Loamy sand	SP-SM, SM	A-2, A-1	0	95-100	75-100	35-75	10-30	---	NP
Graycalm	9-44	Sand, loamy sand, loamy coarse sand.	SM, SP-SM, SP	A-2, A-1, A-3	0	95-100	75-100	30-75	0-30	---	NP
	44-60	Sand, coarse sand	SP, SP-SM, SM	A-2, A-1, A-3	0	95-100	75-100	35-55	0-15	---	NP
139B	0-12	Loamy fine sand	SM, SP-SM	A-2-4	0	90-100	80-95	65-80	10-30	<20	NP-3
Huntersville	12-24	Loamy sand, cobbly loamy sand, sand.	SM, SP-SM	A-2-4, A-1-b, A-3	0-23	75-95	40-90	30-65	5-15	<20	NP-3
	24-40	Sandy loam	SM, SM-SC, SC	A-2-4, A-1-b	0-10	85-100	70-95	45-50	20-35	<25	NP-9
	40-72	Sandy loam, loamy sand.	SM, SM-SC, SC	A-2-4, A-1-b	0-10	85-100	70-95	45-60	15-35	<25	NP-9
187	0-12	Muck	PT	A-8	---	---	---	---	---	---	---
Haug	12-17	Mucky sandy loam, fine sandy loam, loam.	OL, ML, CL, SM	A-4, A-6	0-3	95-100	90-100	70-85	35-65	15-40	1-15
	17-60	Loam, sandy loam, fine sandy loam.	ML, CL, SM, SC	A-4, A-6	0-3	95-100	70-100	60-95	35-65	15-40	1-15
207A, 207B, 207C-	0-8	Loamy sand	SM, SP-SM	A-2, A-3	0	95-100	90-100	50-75	5-30	<20	NP
Nymore	8-33	Sand, coarse sand, loamy coarse sand.	SM, SP-SM, SP	A-1, A-2, A-3	0	95-100	85-100	45-75	2-15	<20	NP
	33-60	Sand, coarse sand	SP, SP-SM, SM	A-1, A-3, A-2	0	95-100	85-100	45-75	2-15	<20	NP
260	0-12	Loamy sand	SM, SP-SM	A-2, A-1	0	90-100	85-100	35-80	10-25	<20	NP
Duelm	12-36	Loamy sand, loamy coarse sand, sand.	SM, SP-SM	A-2, A-3, A-1	0	90-100	80-100	35-80	5-25	<20	NP
	36-60	Coarse sand, sand	SP, SM, SP-SM	A-2, A-3, A-1	0	90-100	80-100	35-85	3-15	<20	NP
261	0-13	Loamy sand	SM	A-2	0	95-100	92-100	50-75	12-30	<20	NP
Isan	13-30	Sand, loamy sand	SM, SP-SM	A-2	0	95-100	92-100	50-75	10-30	<20	NP
	30-60	Sand, coarse sand	SM, SP	A-1, A-2, A-3	0	85-100	80-100	35-70	2-15	<20	NP

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
374B, 374C, 374D-Rockwood	0-9	Sandy loam	SM	A-2, A-4	5-10	85-100	85-100	60-80	30-40	<25	NP-4
	9-19	Sandy loam, loamy sand.	SM, SM-SC, SC	A-2, A-4	5-10	85-95	85-90	60-75	30-40	<20	1-8
	19-37	Sandy loam	SM, SM-SC, SC	A-2, A-4	5-10	85-95	85-95	60-75	30-40	<25	2-10
	37-55	Sandy loam	SM, SM-SC, SC	A-2, A-4	5-10	85-95	85-95	60-75	30-40	<25	2-10
	55-72	Sandy loam, loamy sand.	SM, SM-SC, SC	A-2, A-4	5-10	85-95	80-90	60-75	25-40	<25	2-10
375-Forada	0-11	Loam	ML	A-4	0	95-100	85-100	70-90	50-70	25-35	NP-10
	11-25	Sandy loam, loam, fine sandy loam.	ML, SM	A-4, A-2	0	95-100	85-100	55-85	30-60	20-40	NP-10
	25-60	Sand, coarse sand, gravelly coarse sand.	SP, SM, SP-SM, GP-GM	A-1, A-2, A-3	0	50-90	50-80	40-70	2-30	---	NP
406A, 406B-Dorset	0-9	Sandy loam	SM, SM-SC	A-4, A-2	0	90-100	85-100	50-70	25-50	<25	NP-5
	9-16	Loam, sandy loam	SM-SC, SC, CL-ML, CL	A-4, A-6	0	90-100	85-100	50-90	35-75	15-30	4-14
	16-21	Gravelly loamy sand, gravelly loamy coarse sand, gravelly sand.	SP-SM, SM, SM-SC, GM	A-1, A-2	0-5	50-90	35-80	20-50	10-25	<20	NP-7
	21-60	Gravelly coarse sand, gravelly sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	40-90	35-80	15-40	0-10	<20	NP
454B-Mahtomedi	0-8	Loamy sand	SM, SM-SC	A-2, A-1	0-2	95-100	60-90	40-86	15-30	<20	NP-4
	8-35	Sand, coarse sand, gravelly sand.	SP-SM, SM	A-2, A-3, A-1	0-15	70-95	50-90	30-75	5-15	<20	NP
	35-60	Sand, coarse sand, gravelly sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-15	55-95	50-90	30-70	2-15	<20	NP
458A-Menahga	0-4	Loamy sand	SM, SP-SM	A-2	0	100	85-100	60-80	10-30	---	NP
	4-24	Coarse sand, sand, loamy coarse sand.	SP, SP-SM	A-3, A-2, A-1	0	100	80-100	30-75	0-10	---	NP
	24-60	Coarse sand, sand	SP, SP-SM	A-3, A-2, A-1	0	100	80-100	30-75	0-10	---	NP
458B-Menahga	0-4	Loamy coarse sand	SM, SP-SM	A-2	0	100	85-100	60-80	10-30	---	NP
	4-24	Coarse sand, sand, loamy coarse sand.	SP, SP-SM	A-3, A-2, A-1	0	100	80-100	30-75	0-10	---	NP
	24-60	Coarse sand, sand	SP, SP-SM	A-3, A-2, A-1	0	100	80-100	30-75	0-10	---	NP
458C, 458E-Menahga	0-4	Loamy sand	SM, SP-SM	A-2	0	100	85-100	60-80	10-30	---	NP
	4-24	Coarse sand, sand, loamy coarse sand.	SP, SP-SM	A-3, A-2, A-1	0	100	80-100	30-75	0-10	---	NP
	24-60	Coarse sand, sand	SP, SP-SM	A-3, A-2, A-1	0	100	80-100	30-75	0-10	---	NP
540-Seelyeville	0-22	Muck	PT	A-8	0	---	---	---	---	---	---
	22-60	Sapric material	PT	A-8	0	---	---	---	---	---	---

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
541----------	0-16	Mucky peat-------	PT	A-8	0	---	---	---	---	---	---
Rifle	16-60	Hemic material---	PT	A-8	0	---	---	---	---	---	---
543----------	0-26	Muck-------------	PT	A-8	0	---	---	---	---	---	---
Markey	26-60	Sand, loamy sand, fine sand.	SP, SM, SP-SM	A-2, A-3	0	100	85-100	60-75	0-20	---	NP
544----------	0-26	Muck-------------	PT	A-8	0	---	---	---	---	---	---
Cathro	26-60	Sandy loam, loam, silt loam.	SM, ML, SC, CL	A-4	0-5	80-100	75-100	60-100	35-90	<25	3-10
545----------	0-38	Muck-------------	PT	A-8	0	---	---	---	---	---	---
Rondeau	38-60	Marl-------------	OH, MH	A-8, A-5, A-7	0	100	95-100	80-90	60-80	50-90	NP-20
567A, 567B-------	0-9	Sandy loam-------	SM, SM-SC	A-4, A-2-4	0	100	85-100	60-85	25-45	<20	3-6
Verndale	9-19	Sandy loam, fine sandy loam, loam.	SC, SM-SC	A-4, A-2-4	0	98-100	85-100	60-85	25-45	20-26	5-10
	19-49	Loamy sand, sand, coarse sand.	SM, SP-SM	A-3, A-2-4	0	98-100	85-100	50-65	5-20	---	NP-2
	49-60	Sand, coarse sand	SP, SP-SM	A-3, A-1-b, A-2-4	0	96-100	75-100	45-60	3-10	---	NP
701----------	0-3	Mucky loam-------	ML, CL	A-4, A-6	2-5	95-100	90-95	80-90	50-80	30-40	5-15
Runeberg	3-26	Sandy loam-------	SM, SC, SM-SC	A-2, A-4	5-10	85-95	80-95	60-75	30-45	15-25	3-10
	26-60	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	5-10	85-95	80-95	60-75	30-45	15-25	3-8
720B----------	0-9	Sandy loam-------	SM, SM-SC	A-2, A-4	5-10	85-100	85-100	60-80	30-40	20-30	1-7
Blowers	9-25	Sandy loam-------	SM, SM-SC	A-2, A-4	5-10	85-95	85-90	60-75	30-40	<20	1-5
	25-32	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	5-10	85-95	85-95	60-75	30-40	<25	2-10
	32-49	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	5-10	85-95	85-95	60-75	30-40	<25	2-10
	49-60	Sandy loam, loamy sand.	SM, SM-SC, SC	A-2, A-4	5-10	85-95	80-90	60-75	25-40	<25	2-10
793*:											
Paddock, very stony----------	0-7	Loam-------------	ML, CL	A-4, A-6	2-15	95-100	90-95	80-90	55-80	30-40	7-15
	7-17	Sandy loam, fine sandy loam.	SM, SM-SC	A-2, A-4	5-10	85-95	85-90	60-75	25-40	<20	1-5
	17-40	Sandy loam, sandy clay loam.	SM, SM-SC, SC	A-2, A-4	5-10	85-95	85-95	60-75	25-45	<25	2-10
	40-60	Sandy loam, loamy sand.	SM, SM-SC, SC	A-2, A-4	5-10	85-95	80-90	60-75	25-40	<20	2-8
Paddock---------	0-5	Loam-------------	ML, CL	A-4, A-6	2-5	95-100	90-95	80-90	55-80	30-40	7-15
	5-19	Sandy loam, fine sandy loam.	SM, SM-SC	A-2, A-4	5-10	85-95	85-90	60-75	25-40	<20	1-5
	19-50	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	5-10	85-95	85-95	60-75	25-45	<25	2-10
	50-60	Sandy loam, loamy sand.	SM, SM-SC, SC	A-2, A-4	5-10	85-90	80-90	60-75	25-40	<20	2-8

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
834*:											
Friendship	0-8	Loamy sand	SM, SP-SM	A-1, A-2	0	75-100	75-100	40-75	12-30	---	NP
	8-46	Sand	SP-SM, SM, SP	A-1, A-3, A-2	0	75-100	75-100	40-70	3-15	---	NP
	46-60	Sand	SP-SM, SM, SP	A-1, A-3, A-2	0	75-100	75-100	40-70	3-15	---	NP
Meehan	0-8	Loamy sand	SM	A-2, A-1	0	90-100	75-100	40-90	15-30	---	NP
	8-40	Sand, loamy sand, loamy coarse sand.	SM, SP-SM, SP	A-1, A-2, A-3	0	90-100	75-100	40-90	3-30	---	NP
	40-60	Sand, coarse sand	SP, SP-SM	A-1, A-3, A-2	0	90-100	75-100	40-90	0-5	---	NP
1010*. Riverwash											
1015*. Psamments											
1030*: Udorthents.											
Pits.											
1941 Evart	0-10	Loam	ML, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	75-95	55-85	<30	3-11
	10-60	Sand, loamy sand, gravelly coarse sand.	SM, SP-SM, SM-SC, SP	A-1, A-3, A-2	0-5	95-100	60-100	30-75	0-30	<25	NP-7
1942 Forada	0-16	Mucky loam	ML	A-4	0	95-100	85-100	70-90	50-70	25-35	NP-10
	16-38	Sandy loam, loam, fine sandy loam.	ML, SM	A-4, A-2	0	95-100	85-100	55-85	30-60	20-40	NP-10
	38-60	Sand, coarse sand, gravelly coarse sand.	SP, SM, SP-SM, GP-GM	A-1, A-2, A-3	0	50-90	50-80	40-70	2-30	---	NP
1943 Roscommon	0-7	Loamy sand	SM, SP-SM	A-2, A-3, A-4	0	100	95-100	50-75	5-40	---	NP
	7-60	Sand, loamy sand, coarse sand.	SP, SP-SM, SM	A-1, A-2, A-3	0	95-100	85-100	40-70	0-15	---	NP
1956 Staples	0-7	Loamy sand	SM, SP-SM	A-2-4	0	90-100	80-95	65-80	10-30	<20	NP-4
	7-36	Loamy sand, sand, loamy fine sand.	SM, SP-SM	A-3, A-2-4, A-1-b	0-23	75-95	40-90	30-65	5-15	<20	NP-4
	36-44	Sandy loam	SM, SC, SM-SC	A-2-4, A-1-b	0-10	85-95	70-95	45-67	20-35	<25	NP-9
	44-60	Sandy loam, loamy sand.	SM, SM-SC, SC	A-2-4, A-1-b	0-10	85-95	70-95	45-67	20-35	<25	NP-9
1957B Friendship	0-3	Loamy sand	SP-SM, SM	A-1, A-2	0	75-100	75-100	40-75	12-30	---	NP
	3-44	Sand, fine sand, loamy sand.	SP-SM, SM, SP	A-1, A-2, A-3	0	75-100	75-100	40-75	3-30	---	NP
	44-60	Sandy loam, loam	SC, SM-SC	A-4, A-2	0-10	90-100	70-100	45-70	25-40	20-30	4-10

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
1968---------- Evart	0-11	Loam----------	ML, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	75-95	55-85	<30	3-11
	11-60	Sand, loamy sand, gravelly coarse sand.	SM, SP-SM, SM-SC, SP	A-1, A-3, A-2	0-5	95-100	60-100	30-75	0-30	<25	NP-7
1969*:											
Evart-----------	0-13	Loam----------	ML, CL, CL-ML	A-4, A-6	0-5	95-100	90-100	75-95	55-85	<30	3-11
	13-60	Sand, loamy sand, gravelly coarse sand.	SM, SP-SM, SM-SC, SP	A-1, A-3, A-2	0-5	95-100	60-100	30-75	0-30	<25	NP-7
Isan----------	0-13	Sandy loam-------	SM-SC, SM	A-2	0	95-100	92-100	50-75	15-35	<20	2-5
	13-27	Sand, loamy sand	SM, SP-SM	A-2	0	95-100	92-100	50-75	10-30	<20	NP
	27-60	Sand, coarse sand	SM, SP	A-1, A-2, A-3	0	85-100	80-100	35-70	2-15	<20	NP
1970B----------	0-8	Loamy sand-------	SM, SP-SM	A-2-4	0-1	90-100	80-95	65-80	10-30	---	NP
Menahga	8-55	Sand, loamy sand	SM, SP-SM	A-2-4, A-3	0-10	85-100	80-95	50-75	5-30	---	NP
	55-60	Sandy loam, loamy sand.	SM, SM-SC, SC	A-2-4, A-1-b	0-10	85-100	70-95	45-70	15-35	<25	NP-9
1975----------	0-10	Sandy loam-------	SM, SM-SC	A-2-4, A-4	0	100	85-100	60-85	25-45	<20	3-6
Oylen	10-18	Loam, sandy loam	SC, SM-SC, CL, CL-ML	A-4	0	100	85-100	60-85	35-60	20-30	5-10
	18-38	Loamy sand, sand, coarse sand.	SM, SP-SM	A-3, A-2-4	0	98-100	85-100	50-65	5-20	---	NP
	38-60	Sand, coarse sand, gravelly sand.	SP, SP-SM	A-3, A-1-b, A-2-4	0	90-100	60-100	35-55	3-10	---	NP
1984----------	0-9	Muck----------	PT	A-8	0	---	---	---	---	---	---
Leafriver	9-14	Loamy sand, sandy loam, fine sand.	SM	A-4, A-2-4	0	100	95-100	55-80	15-40	<20	NP-4
	14-60	Loamy sand, fine sand, sand.	SM, SP-SM, SP	A-3, A-2, A-2-4, A-1-b	0	95-100	80-100	45-70	3-35	---	NP
1985----------	0-8	Silt loam--------	ML, CL, SM, SC	A-4, A-6	0-15	80-100	75-100	65-100	49-95	20-35	3-15
Fordum	8-35	Silt loam, fine sandy loam, loam.	SM, SC, ML, CL	A-2, A-4, A-1	0-15	80-100	75-100	45-100	20-90	<30	3-10
	35-60	Stratified sand to silt loam.	SM, SP-SM	A-2, A-1, A-4	0-15	80-100	75-100	35-100	10-50	---	NP

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
82B, 82C---------	0-3	2-6	1.45-1.60	6.0-20	0.10-0.12	5.1-7.3	Low----------	0.17	5	2	1-3
Redeye	3-18	2-6	1.45-1.60	6.0-20	0.07-0.10	5.1-6.5	Low----------	0.15			
	18-26	2-6	1.45-1.65	6.0-20	0.07-0.10	5.6-6.5	Low----------	0.15			
	26-52	6-18	1.65-1.80	0.2-0.6	0.11-0.13	5.1-7.3	Low----------	0.28			
	52-60	5-14	1.80-2.00	<0.06	0-0.04	7.4-8.4	Low----------	0.28			
126----------	0-9	0-10	1.30-1.55	6.0-20	0.06-0.12	4.5-6.5	Low----------	0.17	5	2	.5-2
Graycalm	9-44	0-10	1.50-1.65	6.0-20	0.04-0.09	4.5-7.3	Low----------	0.15			
	44-60	0-10	1.50-1.65	6.0-20	0.04-0.06	5.6-8.4	Low----------	0.15			
139B----------	0-12	2-6	1.45-1.60	6.0-20	0.10-0.12	5.1-7.3	Low----------	0.17	4	2	1-3
Huntersville	12-24	2-6	1.45-1.65	6.0-20	0.04-0.10	5.1-7.3	Low----------	0.15			
	24-40	6-18	1.65-1.80	0.2-0.6	0.11-0.13	5.1-7.3	Low----------	0.20			
	40-72	6-15	1.80-2.00	<0.06	0-0.04	6.6-7.8	Low----------	0.20			
187----------	0-12	---	0.13-0.42	0.6-6.0	0.35-0.48	6.6-7.8	----------	----	5	2	50-90
Haug	12-17	10-18	1.20-1.60	0.6-6.0	0.12-0.24	6.6-8.4	Low----------	0.20			
	17-60	10-18	1.40-1.60	0.6-2.0	0.11-0.19	7.4-8.4	Low----------	0.20			
207A, 207B, 207C-	0-8	2-12	1.45-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.17	5	2	1-3
Nymore	8-33	0-5	1.55-1.65	6.0-20	0.02-0.08	5.1-7.3	Low----------	0.17			
	33-60	0-5	1.55-1.65	6.0-20	0.02-0.08	5.6-7.8	Low----------	0.17			
260----------	0-12	2-10	1.40-1.60	6.0-20	0.08-0.12	5.6-7.3	Low----------	0.17	5	2	2-6
Duelm	12-36	1-8	1.55-1.65	6.0-20	0.06-0.11	5.1-7.3	Low----------	0.15			
	36-60	0-6	1.55-1.65	6.0-20	0.02-0.07	5.6-7.3	Low----------	0.15			
261----------	0-13	2-8	1.30-1.60	6.0-20	0.08-0.12	5.6-7.3	Low----------	0.17	5	2	3-8
Isan	13-30	2-8	1.50-1.65	6.0-20	0.06-0.10	5.1-6.5	Low----------	0.17			
	30-60	1-5	1.55-1.70	6.0-20	0.04-0.06	5.6-7.3	Low----------	0.17			
374B, 374C, 374D-	0-9	5-15	1.55-1.75	0.6-2.0	0.13-0.18	5.1-6.5	Low----------	0.24	5	3	2-4
Rockwood	9-19	5-10	1.60-1.75	0.6-2.0	0.12-0.15	5.1-6.5	Low----------	0.28			
	19-37	8-18	1.60-1.75	0.6-2.0	0.12-0.15	5.6-7.3	Low----------	0.28			
	37-55	8-18	1.65-1.80	0.2-0.6	0.12-0.15	5.6-7.3	Low----------	0.28			
	55-72	7-15	1.80-2.00	<0.06	0-0.04	6.1-8.4	Low----------	0.24			
375----------	0-11	10-22	1.20-1.40	0.6-2.0	0.20-0.22	6.1-7.8	Low----------	0.28	4	5	5-9
Forada	11-25	8-18	1.30-1.50	2.0-6.0	0.12-0.19	6.1-7.8	Low----------	0.28			
	25-60	0-5	1.50-1.70	6.0-20	0.02-0.04	6.6-8.4	Low----------	0.15			
406A, 406B-------	0-9	4-18	1.40-1.55	2.0-6.0	0.13-0.15	5.6-7.3	Low----------	0.20	3	3	3-5
Dorset	9-16	10-18	1.45-1.65	2.0-6.0	0.12-0.19	5.6-7.3	Low----------	0.28			
	16-21	5-10	1.55-1.65	6.0-20	0.06-0.10	5.6-7.8	Low----------	0.10			
	21-60	0-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.10			
454B----------	0-8	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	5	2	<1
Mahtomedi	8-35	0-10	1.45-1.70	6.0-20	0.05-0.07	5.1-6.5	Low----------	0.10			
	35-60	0-10	1.45-1.75	6.0-20	0.04-0.09	5.1-7.8	Low----------	0.10			
458A, 458B, 458C, 458E----------	0-4	2-10	1.20-1.50	6.0-20	0.10-0.12	4.5-6.5	Low----------	0.15	5	2	.5-2
Menahga	4-24	0-5	1.50-1.65	6.0-20	0.05-0.07	4.5-6.5	Low----------	0.15			
	24-60	0-5	1.50-1.65	6.0-20	0.05-0.07	5.6-7.3	Low----------	0.15			
540----------	0-22	---	0.10-0.25	0.2-6.0	0.35-0.45	4.5-8.4	----------	----	5	2	>25
Seelyeville	22-60	---	0.10-0.25	0.2-6.0	0.35-0.45	4.5-8.4	----------	----			

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
541	0-16	---	0.20-0.35	0.6-6.0	0.35-0.45	4.5-7.3			5	5	55-85
Rifle	16-60	---	0.08-0.20	0.6-6.0	0.45-0.55	4.5-7.3					
543	0-26	---	0.15-0.45	0.2-6.0	0.35-0.45	5.6-7.8			4	2	55-85
Markey	26-60	0-10	1.40-1.65	6.0-20	0.03-0.08	5.6-8.4	Low	0.32			
544	0-26	---	0.28-0.45	0.2-6.0	0.45-0.55	4.5-7.8			5	2	60-85
Cathro	26-60	10-25	1.50-1.70	0.2-2.0	0.11-0.22	6.6-8.4	Low	0.28			
545	0-38	0-10	0.10-0.25	0.2-6.0	0.35-0.48	5.1-7.8			5	2	>25
Rondeau	38-60	5-15	0.05-0.20	<0.2	0.20-0.22	7.4-7.8					
567A, 567B	0-9	7-12	1.50-1.70	2.0-6.0	0.13-0.17	5.6-7.3	Low	0.20	3	3	2-4
Verndale	9-19	7-18	1.60-1.70	0.6-2.0	0.14-0.18	6.1-7.3	Low	0.24			
	19-49	2-6	1.45-1.60	6.0-20	0.06-0.08	6.1-7.3	Low	0.10			
	49-60	0-4	1.45-1.60	6.0-20	0.02-0.06	6.6-8.4	Low	0.10			
701	0-3	10-25	1.40-1.55	0.6-2.0	0.18-0.25	6.1-7.3	Low	0.32	5	5	4-12
Runeberg	3-26	10-18	1.60-1.75	0.2-0.6	0.12-0.18	6.1-7.3	Low	0.28			
	26-60	6-15	1.65-1.75	0.06-0.6	0.06-0.13	7.4-8.4	Low	0.28			
720B	0-9	5-15	1.55-1.80	0.6-2.0	0.13-0.18	5.1-7.3	Low	0.24	4	3	2-6
Blowers	9-25	5-10	1.60-1.80	0.6-2.0	0.12-0.15	5.1-6.5	Low	0.28			
	25-32	8-18	1.60-1.75	0.6-2.0	0.12-0.15	5.6-7.3	Low	0.24			
	32-49	8-18	1.65-1.80	0.2-0.6	0.12-0.15	5.6-7.3	Low	0.24			
	49-60	7-15	1.80-2.00	<0.06	0-0.04	6.6-8.4	Low	0.24			
793*:											
Paddock, very stony	0-7	10-20	1.40-1.60	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.32	4	8	3-7
	7-17	3-10	1.50-1.75	0.6-2.0	0.12-0.15	5.6-6.5	Low	0.28			
	17-40	8-18	1.60-1.80	0.2-0.6	0.12-0.15	5.6-7.3	Low	0.28			
	40-60	6-15	1.80-2.00	<0.06	0-0.04	7.4-8.4	Low	0.28			
Paddock	0-5	10-20	1.40-1.60	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.32	5	5	3-7
	5-19	3-10	1.50-1.75	0.6-2.0	0.12-0.16	5.6-6.5	Low	0.24			
	19-50	8-18	1.60-1.80	0.2-0.6	0.12-0.16	5.6-7.3	Low	0.24			
	50-60	6-15	1.80-2.00	<0.06	0-0.04	7.4-8.4	Low	0.24			
834*:											
Friendship	0-8	3-8	1.50-1.65	6.0-20	0.08-0.12	5.1-6.5	Low	0.17	5	2	.5-2
	8-46	0-4	1.50-1.65	6.0-20	0.05-0.08	5.1-7.3	Low	0.15			
	46-60	0-4	1.50-1.70	6.0-20	0.04-0.07	6.1-7.8	Low	0.15			
Meehan	0-8	4-10	1.35-1.65	6.0-20	0.10-0.12	3.6-6.5	Low	0.17	5	2	.5-3
	8-40	4-9	1.60-1.70	6.0-20	0.06-0.11	5.1-7.3	Low	0.17			
	40-60	1-4	1.60-1.70	6.0-20	0.02-0.07	5.1-7.3	Low	0.17			
1010*.											
Riverwash											
1015*.											
Psamments											
1030*:											
Udorthents.											
Pits.											

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
1941----------	0-10	8-20	1.35-1.50	0.6-2.0	0.19-0.22	6.1-7.8	Low----------	0.28	5	5	1-6
Evart	10-60	0-15	1.40-1.65	6.0-20	0.05-0.10	6.1-8.4	Low----------	0.15			
1942----------	0-16	10-22	1.00-1.40	0.6-2.0	0.20-0.22	6.6-7.8	Low----------	0.28	4	5	5-15
Forada	16-38	8-18	1.30-1.50	2.0-6.0	0.12-0.19	6.6-7.8	Low----------	0.28			
	38-60	0-5	1.50-1.70	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.15			
1943----------	0-7	2-12	0.90-1.60	6.0-20	0.07-0.20	5.6-7.8	Low----------	0.17	5	2	4-8
Roscommon	7-60	0-10	1.45-1.75	6.0-20	0.05-0.07	5.6-8.4	Low----------	0.17			
1956----------	0-7	2-6	1.45-1.60	6.0-20	0.10-0.12	5.1-7.3	Low----------	0.17	5	2	2-8
Staples	7-36	2-6	1.45-1.60	6.0-20	0.07-0.10	5.1-7.3	Low----------	0.15			
	36-44	8-18	1.65-1.80	0.2-0.6	0.06-0.13	5.1-7.3	Low----------	0.28			
	44-60	6-15	1.80-2.00	<0.06	0-0.04	6.1-7.8	Low----------	0.28			
1957B----------	0-3	3-10	1.50-1.65	6.0-20	0.08-0.12	5.1-7.3	Low----------	0.17	5	2	.5-2
Friendship	3-44	2-7	1.50-1.65	6.0-20	0.05-0.11	5.1-6.5	Low----------	0.17			
	44-60	10-20	1.60-1.80	0.2-2.0	0.07-0.13	4.5-7.3	Low----------	0.24			
1968----------	0-11	8-20	1.35-1.50	0.6-2.0	0.19-0.22	6.1-7.8	Low----------	0.28	5	5	1-6
Evart	11-60	0-15	1.40-1.65	6.0-20	0.05-0.10	6.1-8.4	Low----------	0.15			
1969*:											
Evart----------	0-13	8-20	1.35-1.50	0.6-2.0	0.19-0.22	6.1-7.8	Low----------	0.28	5	5	1-6
	13-60	0-15	1.40-1.65	6.0-20	0.05-0.10	6.1-8.4	Low----------	0.15			
Isan----------	0-13	5-14	1.30-1.55	6.0-20	0.10-0.15	5.6-7.3	Low----------	0.20	5	3	3-10
	13-27	2-8	1.50-1.65	6.0-20	0.06-0.10	5.1-6.5	Low----------	0.17			
	27-60	1-5	1.55-1.70	6.0-20	0.04-0.06	5.6-7.3	Low----------	0.17			
1970B----------	0-8	2-6	1.45-1.60	6.0-20	0.10-0.12	5.1-7.3	Low----------	0.17	5	2	.5-2
Menahga	8-55	2-6	1.45-1.65	6.0-20	0.07-0.10	5.1-6.5	Low----------	0.15			
	55-60	5-14	1.65-2.00	0.06-0.6	0-0.11	5.1-7.8	Low----------	0.28			
1975----------	0-10	7-12	1.50-1.70	2.0-6.0	0.12-0.16	6.1-7.3	Low----------	0.20	3	3	2-4
Oylen	10-18	7-18	1.60-1.70	0.6-2.0	0.12-0.18	6.1-7.3	Low----------	0.24			
	18-38	2-6	1.45-1.60	6.0-20	0.03-0.08	6.1-7.3	Low----------	0.10			
	38-60	0-4	1.45-1.60	6.0-20	0.03-0.07	6.6-8.4	Low----------	0.10			
1984----------	0-9	---	0.10-0.25	0.6-6.0	0.35-0.50	5.6-7.3	----------	----	3	2	50-90
Leafriver	9-14	3-18	1.40-1.65	2.0-20	0.08-0.14	5.6-7.3	Low----------	0.17			
	14-60	0-10	1.50-1.65	6.0-20	0.03-0.08	5.6-7.3	Low----------	0.17			
1985----------	0-8	10-23	1.35-1.45	0.6-2.0	0.17-0.24	4.5-8.4	Low----------	0.28	5	8	4-12
Fordum	8-35	8-18	1.40-1.50	0.6-6.0	0.10-0.22	4.5-8.4	Low----------	0.32			
	35-60	2-18	1.55-1.70	2.0-6.0	0.04-0.16	4.5-8.4	Low----------	0.15			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
82B, 82C---------- Redeye	B	None--------	---	---	>6.0	---	---	---	Moderate	Moderate	Moderate.
126---------- Graycalm	A	None--------	---	---	>6.0	---	---	---	Low------	Low------	Moderate.
139B---------- Huntersville	B	None--------	---	---	2.5-4.0	Perched	Mar-Dec	---	High-----	Moderate	Moderate.
187---------- Haug	B/D	None--------	---	---	+1-3.0	Apparent	Jan-Dec	10-15	High-----	High-----	Low.
207A, 207B, 207C-- Nymore	A	None--------	---	---	>6.0	---	---	---	Low------	Low------	Moderate.
260---------- Duelm	A	None--------	---	---	2.0-5.0	Apparent	Mar-Jun	---	Moderate	Low------	Moderate.
261---------- Isan	A/D	None--------	---	---	0.5-2.0	Apparent	Oct-Jun	---	Moderate	High-----	Moderate.
374B, 374C, 374D-- Rockwood	C	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Moderate.
375---------- Forada	B/D	None--------	---	---	1.0-3.0	Apparent	Oct-Jun	---	High-----	High-----	Low.
406A, 406B-------- Dorset	B	None--------	---	---	>6.0	---	---	---	Low------	Low------	Moderate.
454B---------- Mahtomedi	A	None--------	---	---	>6.0	---	---	---	Low------	Low------	High.
458A, 458B, 458C, 458E---------- Menahga	A	None--------	---	---	>6.0	---	---	---	Low------	Low------	Moderate.
540---------- Seelyeville	A/D	None--------	---	---	+2-2.0	Apparent	Jan-Dec	50-55	High-----	High-----	Moderate.
541---------- Rifle	A/D	None--------	---	---	+1-1.0	Apparent	Nov-Jun	60-100	High-----	High-----	Low.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
543---------- Markey	A/D	None--------	---	---	+1-1.0	Apparent	Nov-Jun	25-30	High-----	High-----	Low.
544---------- Cathro	A/D	None--------	---	---	+1-1.0	Apparent	Nov-Jun	19-22	High-----	High-----	Low.
545---------- Rondeau	A/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	30-35	High-----	High-----	Low.
567A, 567B-------- Verndale	B	None--------	---	---	>6.0	---	---	---	Low------	Low------	Low.
701---------- Runeberg	C/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	---	High-----	High-----	Low.
720B---------- Blowers	B	None--------	---	---	2.0-3.0	Perched	Oct-Jun	---	High-----	Moderate	Moderate.
793*:											
Paddock, very stony----------	C/D	None--------	---	---	1.0-3.0	Perched	Nov-Jun	---	High-----	High-----	Moderate.
Paddock----------	C/D	None--------	---	---	1.0-3.0	Perched	Nov-Jun	---	High-----	High-----	Moderate.
834*:											
Friendship-------	A	None--------	---	---	2.5-6.0	Apparent	Nov-May	---	Low------	Low------	High.
Meehan----------	B	None--------	---	---	1.0-3.0	Apparent	Nov-May	---	Moderate	Low------	Moderate.
1010*. Riverwash											
1015*. Psamments											
1030*: Udorthents.											
Pits.											
1941---------- Evart	D	Frequent----	Brief to long.	Nov-Jun	0-2.0	Apparent	Jan-Dec	---	Moderate	High-----	Low.
1942---------- Forada	B/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	---	High-----	Low------	Low.
1943---------- Roscommon	A/D	None--------	---	---	0-1.0	Apparent	Sep-Jun	---	Moderate	High-----	Low.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
1956-------------- Staples	B/D	None---------	---	---	0.5-2.0	Perched	Nov-Jul	---	High-----	High-----	Moderate.
1957B------------- Friendship	A	None---------	---	---	3.0-6.0	Perched	Nov-May	---	Low------	Low------	High.
1968-------------- Evart	D	Occasional	Brief to long.	Nov-Jun	0-2.0	Apparent	Jan-Dec	---	Moderate	High-----	Low.
1969*:											
Evart------------	D	Frequent----	Brief to long.	Nov-Jun	0-2.0	Apparent	Jan-Dec	---	Moderate	High-----	Low.
Isan--------------	A/D	None---------	---	---	0.5-2.0	Apparent	Oct-Jun	---	Moderate	High-----	Moderate.
1970B------------- Menahga	A	None---------	---	---	>6.0	---	---	---	Low------	Low------	Moderate.
1975-------------- Oylen	C	None---------	---	---	2.0-5.0	Apparent	Oct-Jun	---	Moderate	Moderate	Low.
1984-------------- Leafriver	A/D	None---------	---	---	+1-1.0	Apparent	Nov-Jul	5-10	High-----	High-----	High.
1985-------------- Fordum	D	Occasional	Brief to long.	Nov-Jun	0-1.0	Apparent	Jan-Dec	---	High-----	High-----	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Blowers	Coarse-loamy, mixed Aquic Eutroboralfs
Cathro	Loamy, mixed, euic Terric Borosaprists
*Dorset	Coarse-loamy, mixed Boralfic Udic Argiborolls
Duelm	Sandy, mixed Aquic Haploborolls
Evart	Sandy, mixed, frigid Fluvaquentic Haplaquolls
Forada	Coarse-loamy, mixed, frigid Typic Haplaquolls
Fordum	Coarse-loamy, mixed, nonacid, frigid Mollic Fluvaquents
Friendship	Mixed, frigid Typic Udipsamments
*Graycalm	Mixed, frigid Alfic Udipsamments
Haug	Coarse-loamy, mixed (calcareous), frigid Histic Humaquepts
Huntersville	Coarse-loamy, mixed Aquic Eutroboralfs
Isan	Sandy, mixed, frigid Typic Haplaquolls
Leafriver	Sandy, mixed, frigid Histic Humaquepts
Mahtomedi	Mixed, frigid Typic Udipsamments
Markey	Sandy or sandy-skeletal, mixed, euic Terric Borosaprists
Meehan	Mixed, frigid Aquic Udipsamments
Menahga	Mixed, frigid Typic Udipsamments
Nymore	Mixed, frigid Typic Udipsamments
Oylen	Coarse-loamy, mixed Aquic Argiborolls
Paddock	Coarse-loamy, mixed, frigid Udollic Ochraqualfs
Psamments	Mixed, frigid Typic Udipsamments
Redeye	Loamy, mixed Arenic Eutroboralfs
Rifle	Euic Typic Borohemists
Rockwood	Coarse-loamy, mixed Mollic Eutroboralfs
Rondeau	Marly, euic Limnic Borosaprists
Roscommon	Mixed, frigid Mollic Psammaquents
Runeberg	Coarse-loamy, mixed, frigid Typic Haplaquolls
Seelyeville	Euic Typic Borosaprists
Staples	Loamy, mixed, frigid Arenic Ochraqualfs
Udorthents	Frigid, mixed Typic Udorthents
Verndale	Coarse-loamy, mixed Udic Argiborolls

* U.S. Government Printing Office: 1991-281-364/40024

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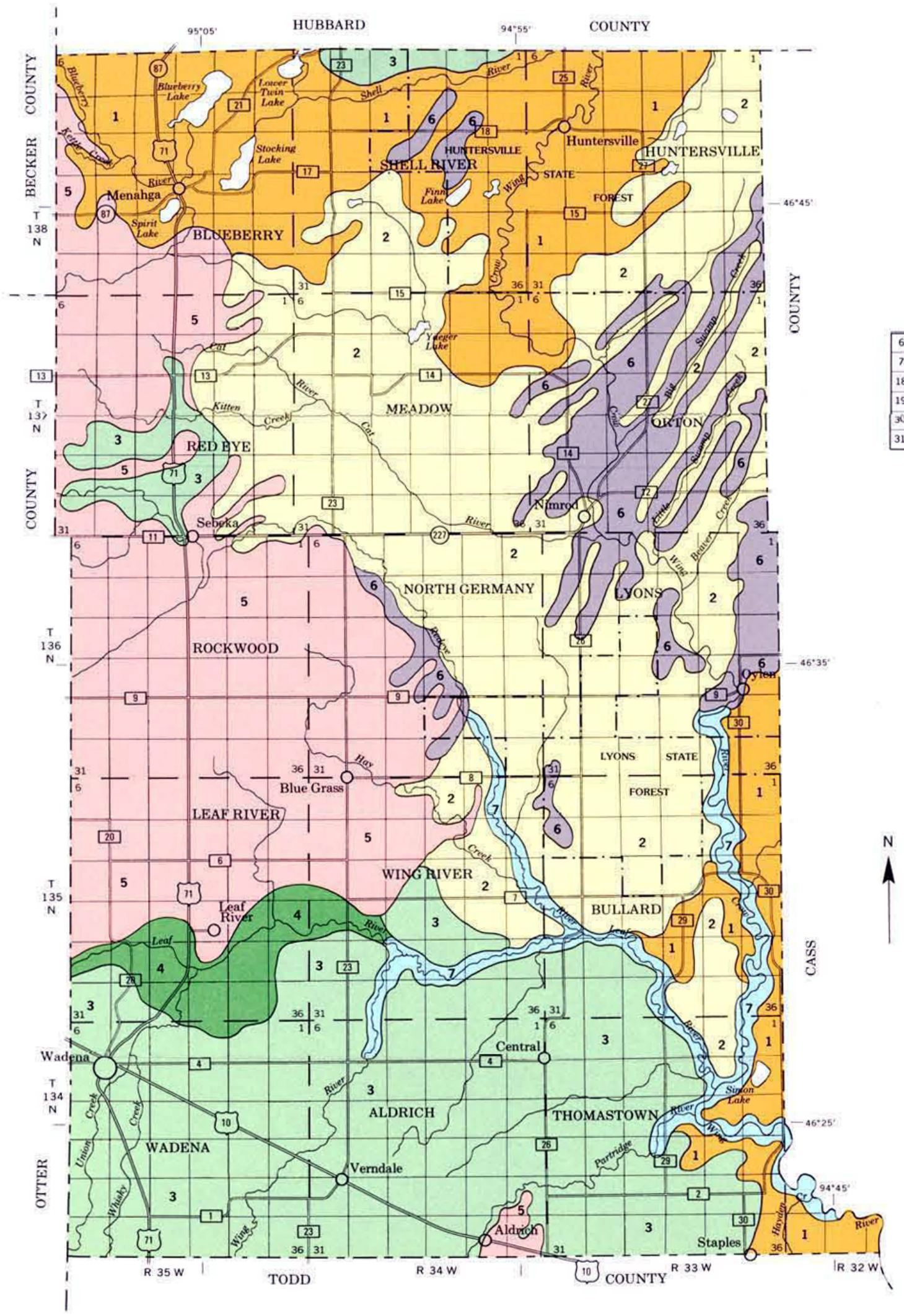
Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

N

SOIL LEGEND*

1 — MENAHGA-FRIENDSHIP-SEELYEVILLE ASSOCIATION: Nearly level to very steep, excessively drained, moderately well drained, and very poorly drained, sandy and organic soils on uplands

2 — MARKEY-MEEHAN-ROSCOMMON ASSOCIATION: Nearly level and gently sloping, very poorly drained to somewhat poorly drained, sandy and organic soils on uplands

3 — VERNDALE-NYMORE-FORADA ASSOCIATION: Nearly level to sloping, very poorly drained, poorly drained, well drained, and excessively drained, loamy and sandy soils on uplands

4 — MARKEY-ISAN-DUELM ASSOCIATION: Nearly level, very poorly drained, poorly drained, and moderately well drained, organic and sandy soils on uplands

5 — BLOWERS-PADDOCK-RUNEBERG ASSOCIATION: Nearly level and gently sloping, moderately well drained, somewhat poorly drained, and very poorly drained, loamy soils on uplands

6 — FRIENDSHIP-MENAHGA-HUNTERSVILLE ASSOCIATION: Nearly level to moderately steep, moderately well drained and excessively drained, sandy soils on uplands

7 — EVART-MENAHGA-FORDUM ASSOCIATION: Nearly level to very steep, very poorly drained, poorly drained, and excessively drained, loamy and sandy soils on flood plains and uplands

* Texture terms in the descriptive headings refer to the surface layer of the major soils in the associations.

Compiled 1990

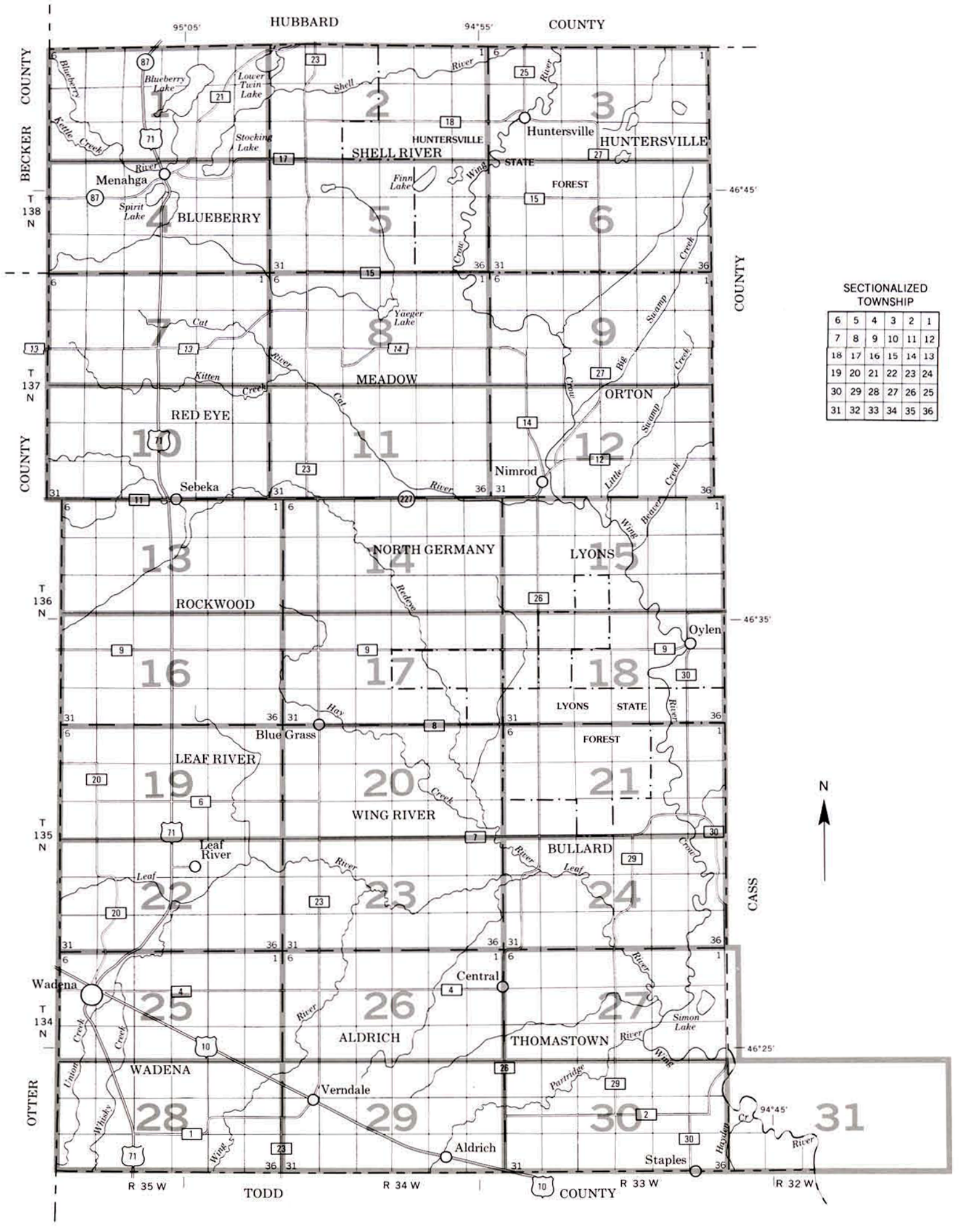
UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MINNESOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

WADENA COUNTY, MINNESOTA

1 0 1 2 3 Mi

1 0 3 6 Km



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS

WADENA COUNTY, MINNESOTA

1 0 1 2 3 Mi

1 0 3 6 Km

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and a letter. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas.

SYMBOL	NAME
82B	Redeye loamy sand, 1 to 6 percent slopes
82C	Redeye loamy sand, 6 to 12 percent slopes
126	Graycalm loamy sand
139B	Huntersville loamy fine sand, 1 to 6 percent slopes
187	Haug muck
207A	Nymore loamy sand, 1 to 3 percent slopes
207B	Nymore loamy sand, 3 to 6 percent slopes
207C	Nymore loamy sand, 6 to 12 percent slopes
260	Duelm loamy sand
261	Isan loamy sand
374B	Rockwood sandy loam, 2 to 6 percent slopes
374C	Rockwood sandy loam, 6 to 12 percent slopes
374D	Rockwood sandy loam, 12 to 18 percent slopes
375	Forada loam
406A	Dorset sandy loam, 1 to 3 percent slopes
406B	Dorset sandy loam, 3 to 6 percent slopes
454B	Mahtomedi loamy sand, 1 to 8 percent slopes
458A	Menahga loamy sand, 0 to 2 percent slopes
458B	Menahga loamy coarse sand, 2 to 6 percent slopes
458C	Menahga loamy sand, 6 to 15 percent slopes
458E	Menahga loamy sand, 15 to 45 percent slopes
540	Seelyeville muck
541	Rifle mucky peat
543	Markey muck
544	Cathro muck
545	Rondeau muck
567A	Verndale sandy loam, 0 to 2 percent slopes
567B	Verndale sandy loam, 2 to 6 percent slopes
701	Runeberg mucky loam
720B	Blowers sandy loam, 1 to 5 percent slopes
793	Paddock complex
834	Friendship-Meehan loamy sands
1010	Riverwash
1015	Psamments, nearly level
1030	Udorthents-Pits, complex
1941	Evart loam, frequently flooded
1942	Forada mucky loam, depressional
1943	Roscommon loamy sand
1956	Staples loamy sand
1957B	Friendship loamy sand, till substratum, 1 to 6 percent slopes
1968	Evart loam, occasionally flooded
1969	Evart-Isan complex, channeled
1970B	Menahga loamy sand, till substratum, 1 to 8 percent slopes
1975	Oylen sandy loam
1984	Leafriver muck
1985	Fordum silt loam, occasionally flooded

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

County or parish

Field sheet matchline & neatline

AD HOC BOUNDARY (label)

Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK

890 000 FEET

LAND DIVISION CORNERS (sections and land grants)

ROAD EMBLEMS & DESIGNATIONS

Federal

State

RAILROAD

DAMS

Medium or small

PITS

Gravel pit

WATER FEATURES

DRAINAGE

Perennial, double line

Perennial, single line

Intermittent

Drainage end

Canals or ditches

Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

Perennial

MISCELLANEOUS WATER FEATURES

Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS

ESCARPMENTS

Other than bedrock (points down slope)

SHORT STEEP SLOPE

MISCELLANEOUS

Gravelly spot

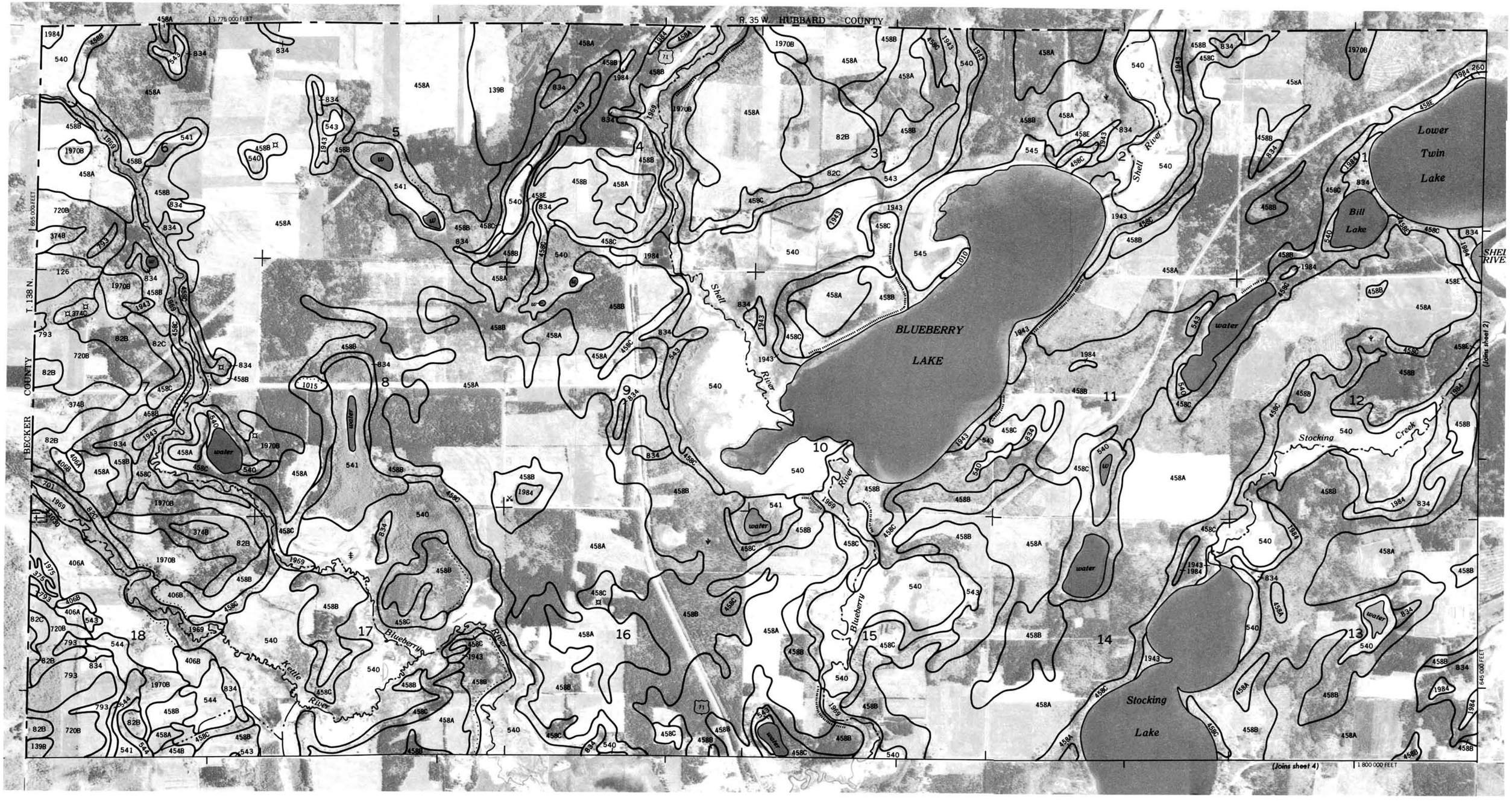
Severely eroded spot

SMALL AREA OF ORGANIC SOIL

SMALL AREA OF MINERAL SOIL WITHIN AN AREA OF ORGANIC SOIL

ACCESS DENIED

SOIL MAP OF WADENA COUNTY, MINNESOTA – SHEET NUMBER 1



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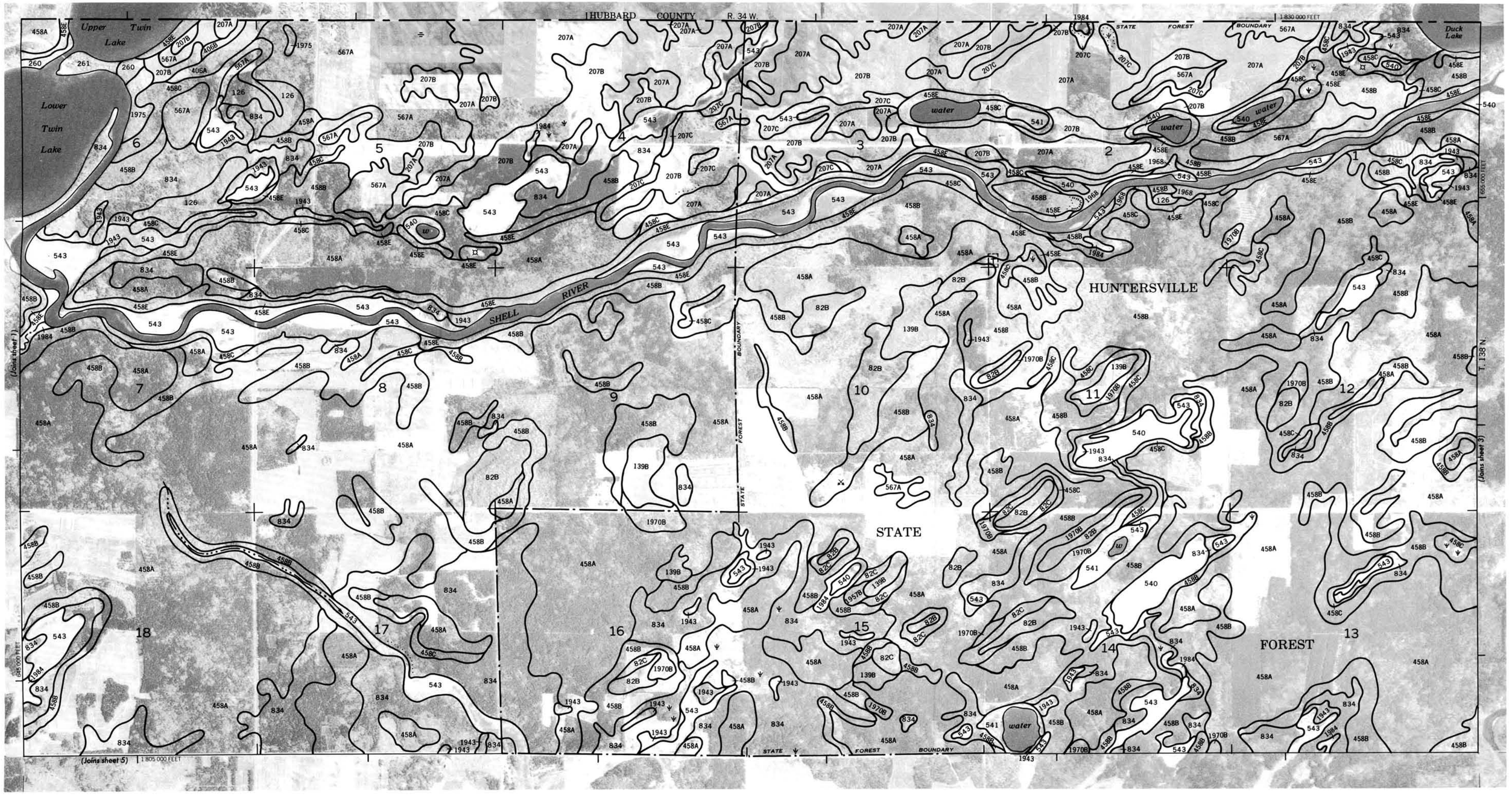

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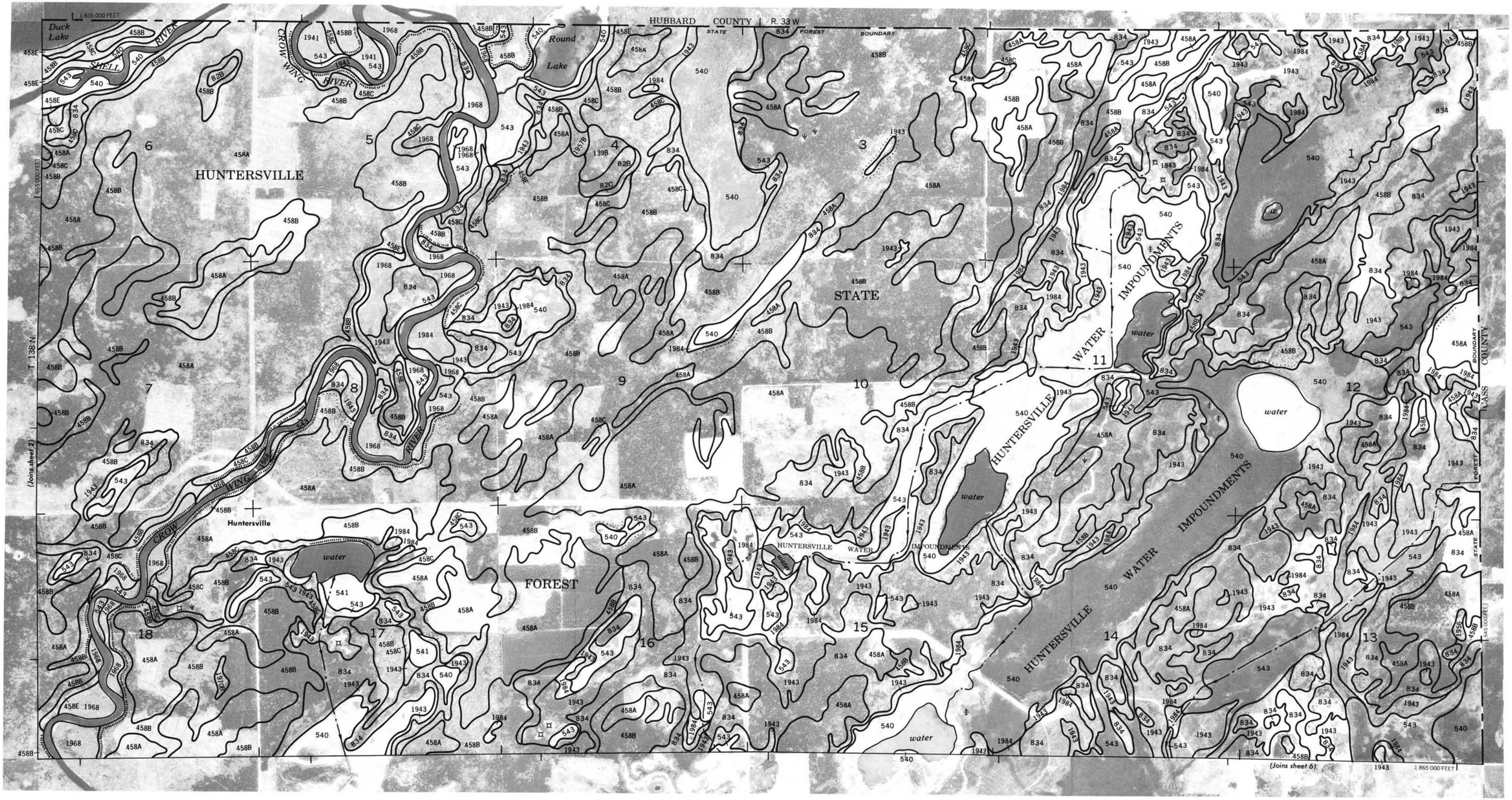
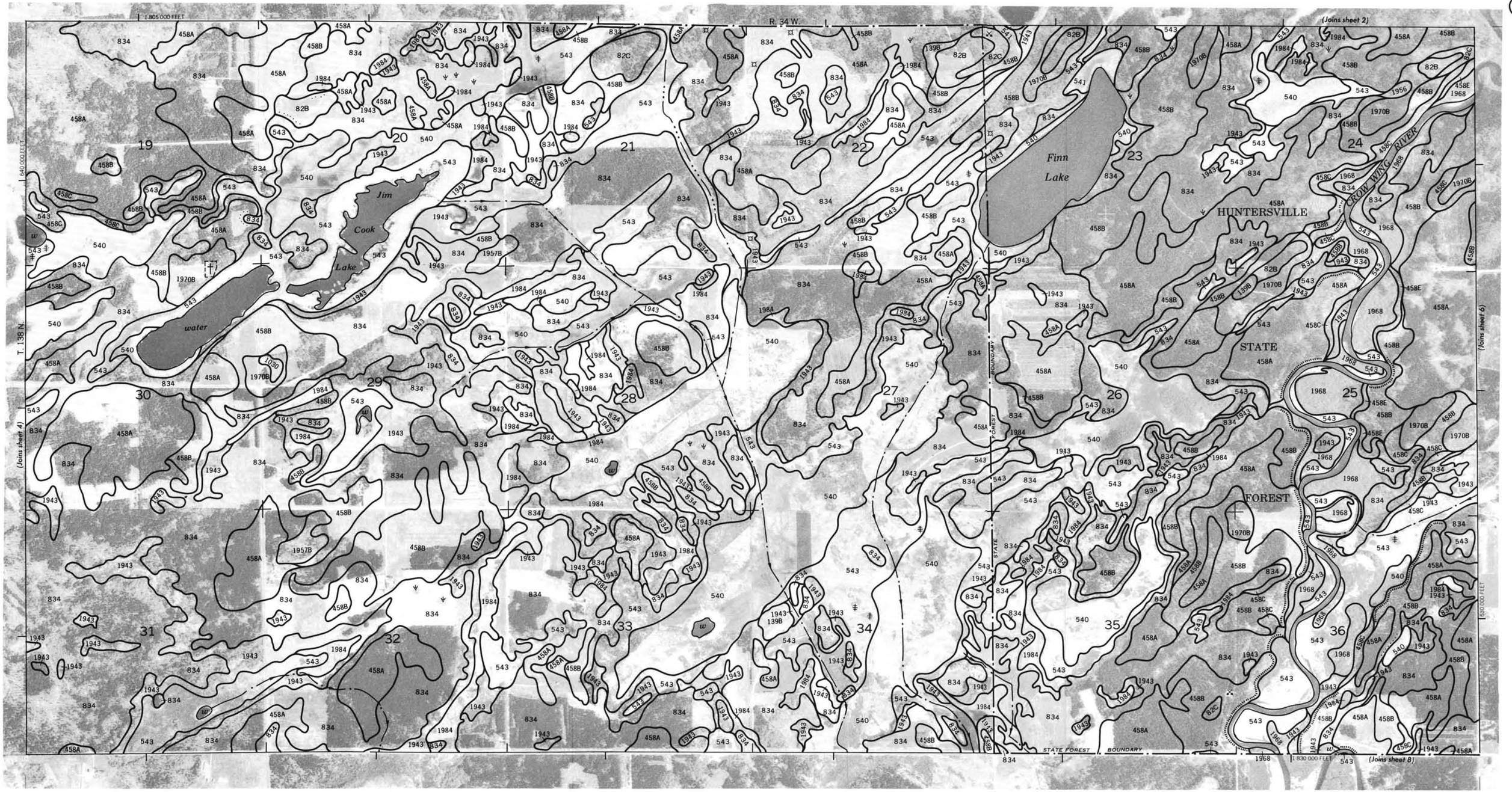


SOIL MAP OF WADENA COUNTY, MINNESOTA – SHEET NUMBER 4

SOIL MAP OF WADENA COUNTY, MINNESOTA – SHEET NUMBER 5



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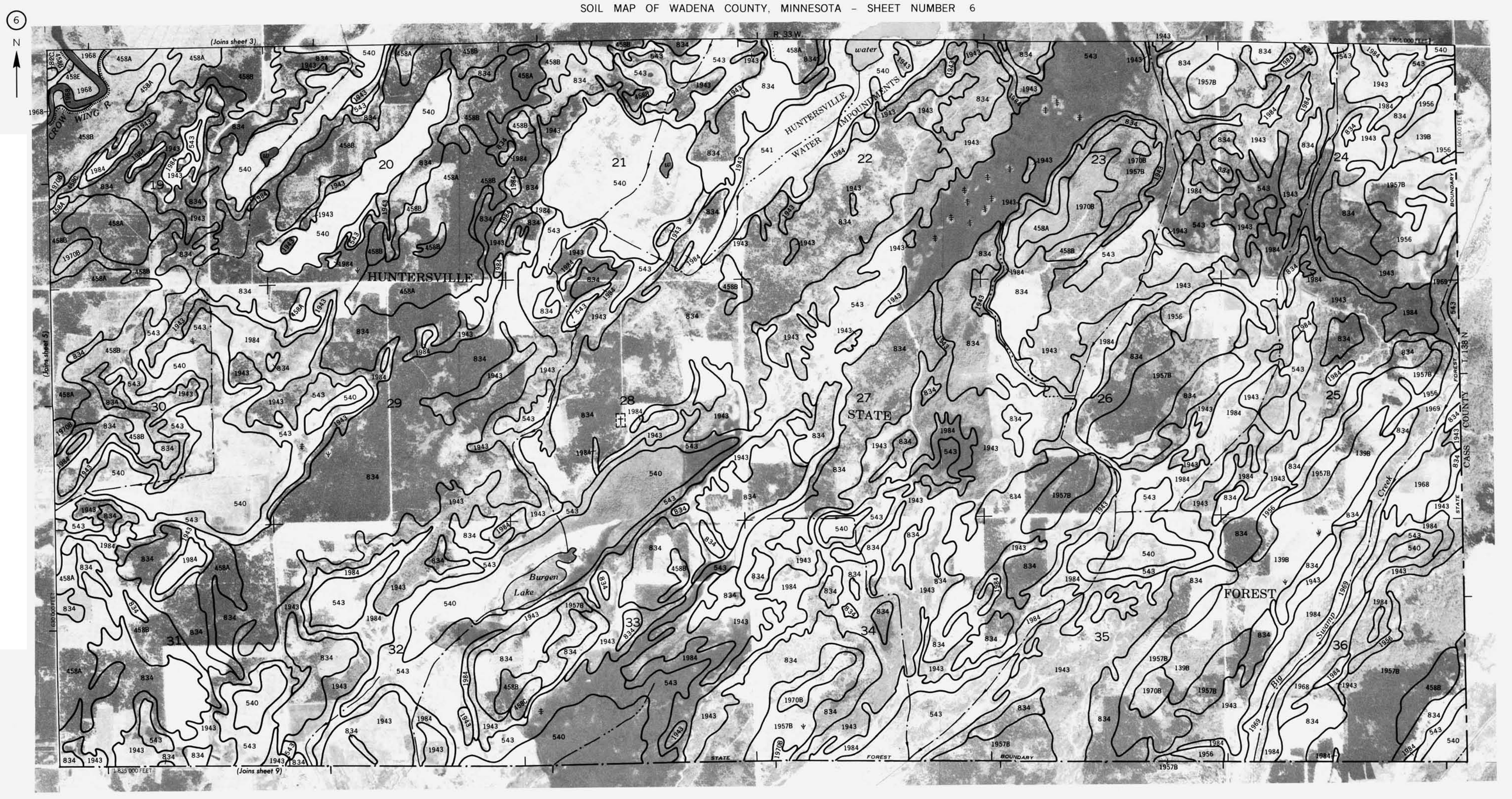

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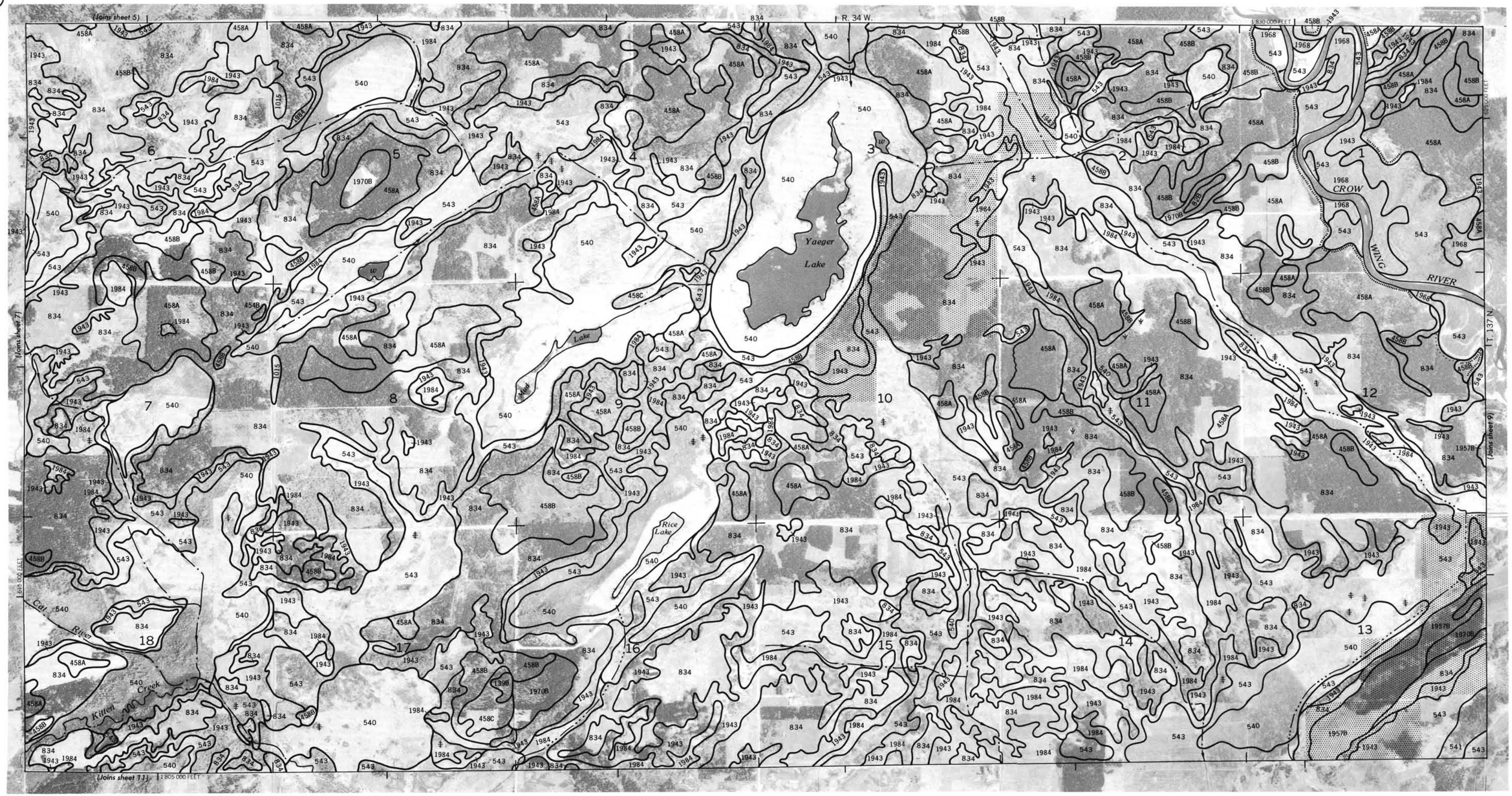
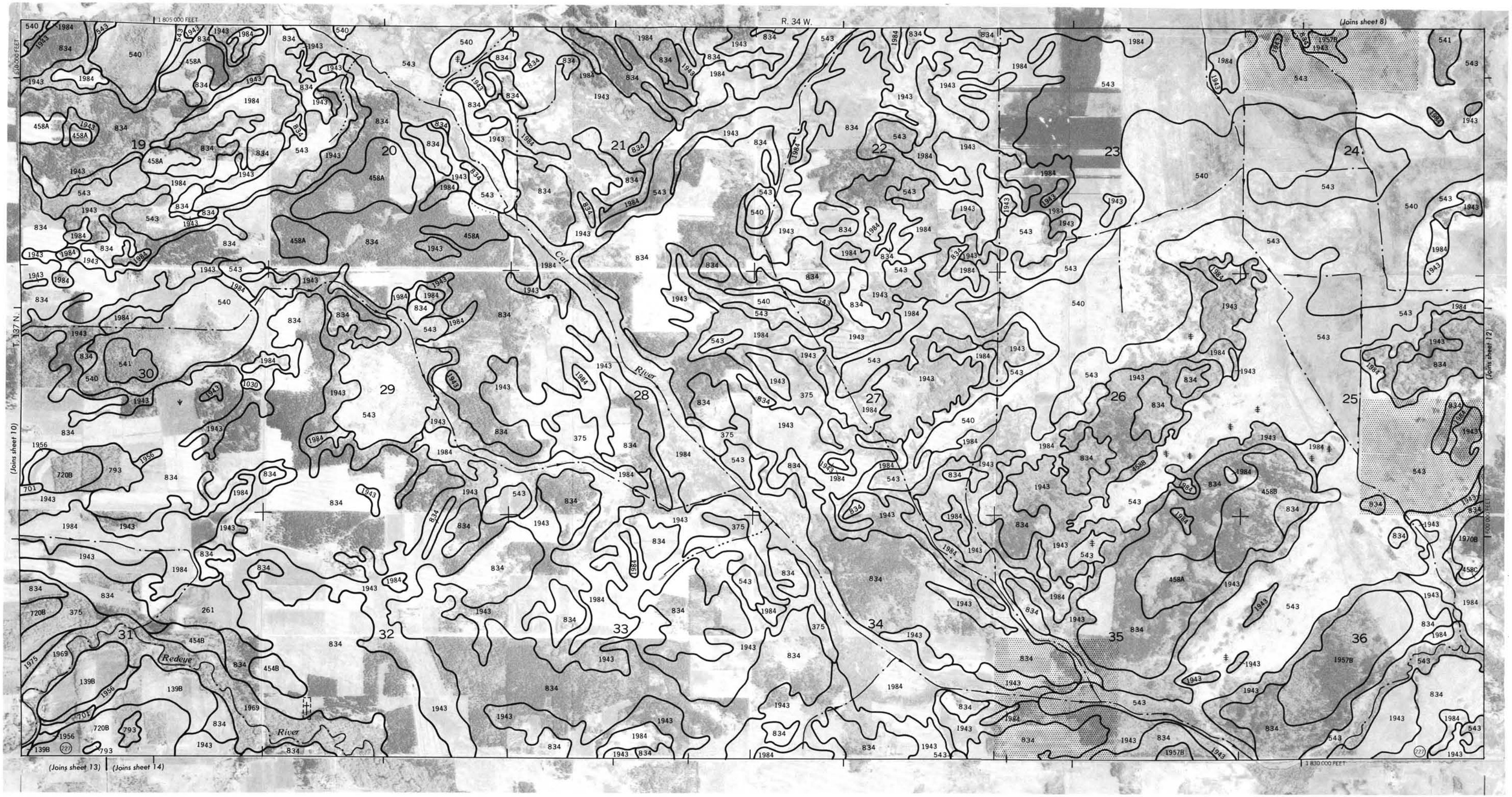
SOIL MAP OF WADENA COUNTY, MINNESOTA – SHEET NUMBER 8



SOIL MAP OF WADENA COUNTY, MINNESOTA – SHEET NUMBER 9

SOIL MAP OF WADENA COUNTY, MINNESOTA – SHEET NUMBER 10

SOIL MAP OF WADENA COUNTY, MINNESOTA – SHEET NUMBER 11



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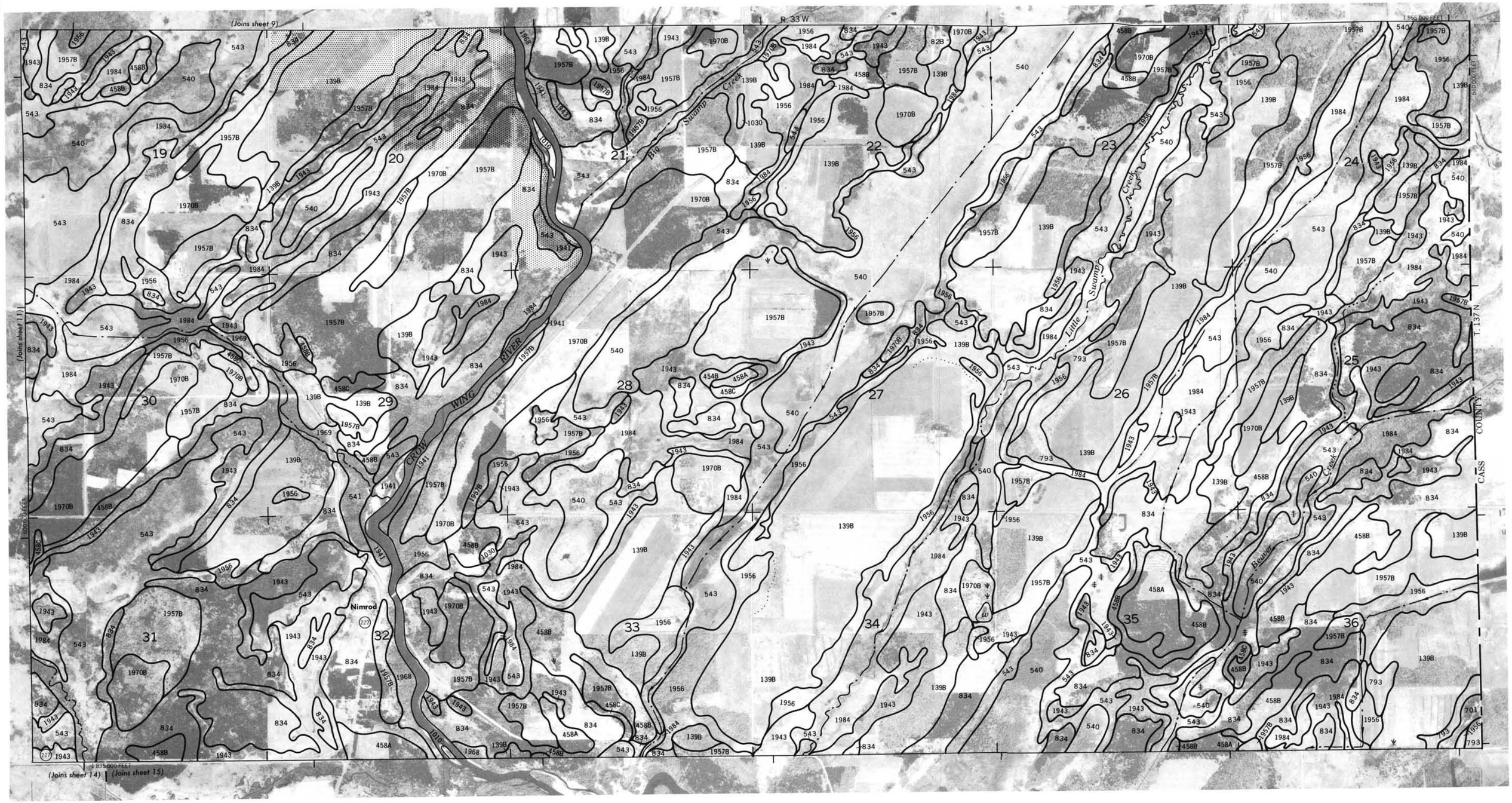
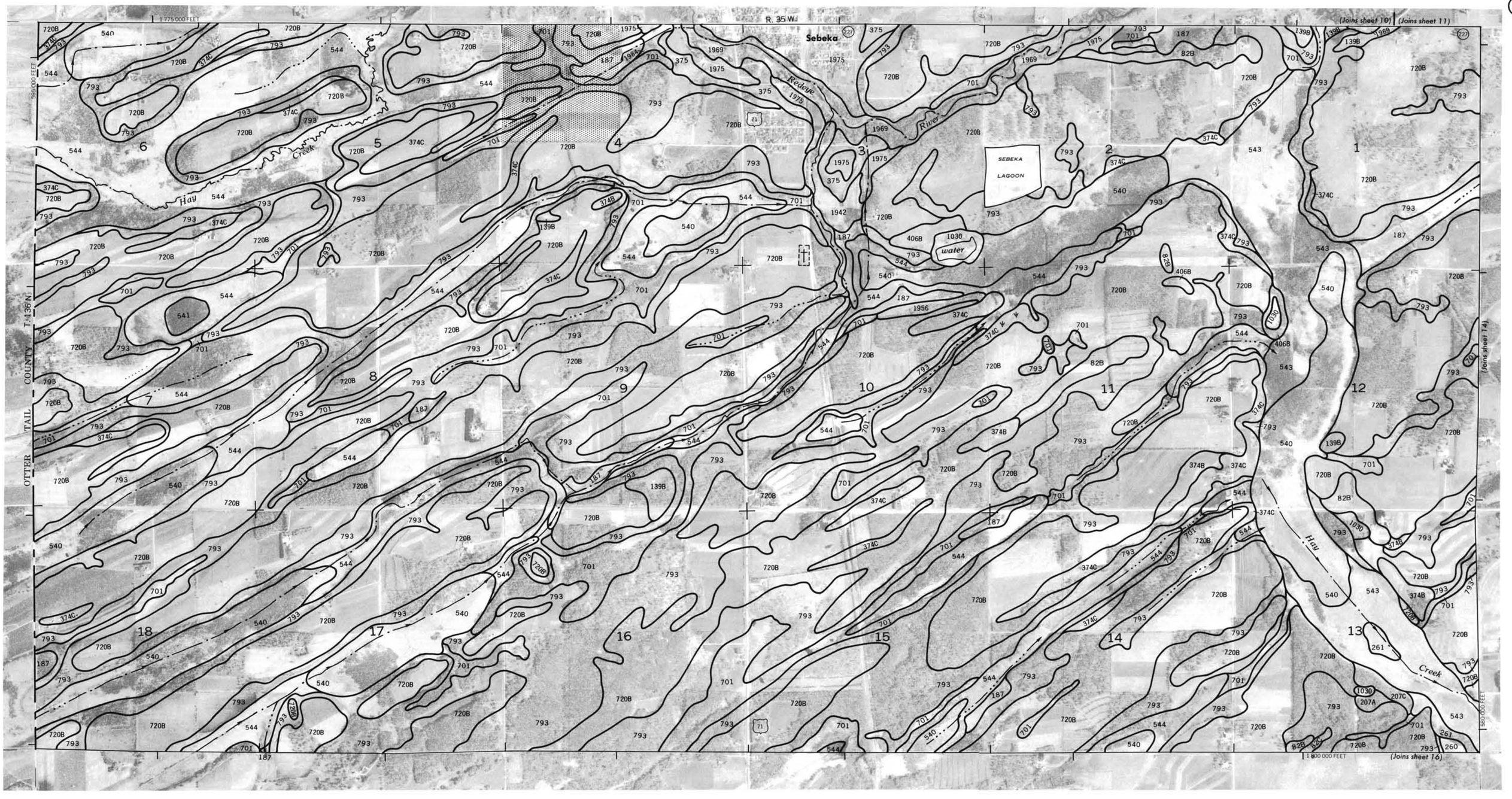


SOIL MAP OF WADENA COUNTY, MINNESOTA – SHEET NUMBER 13



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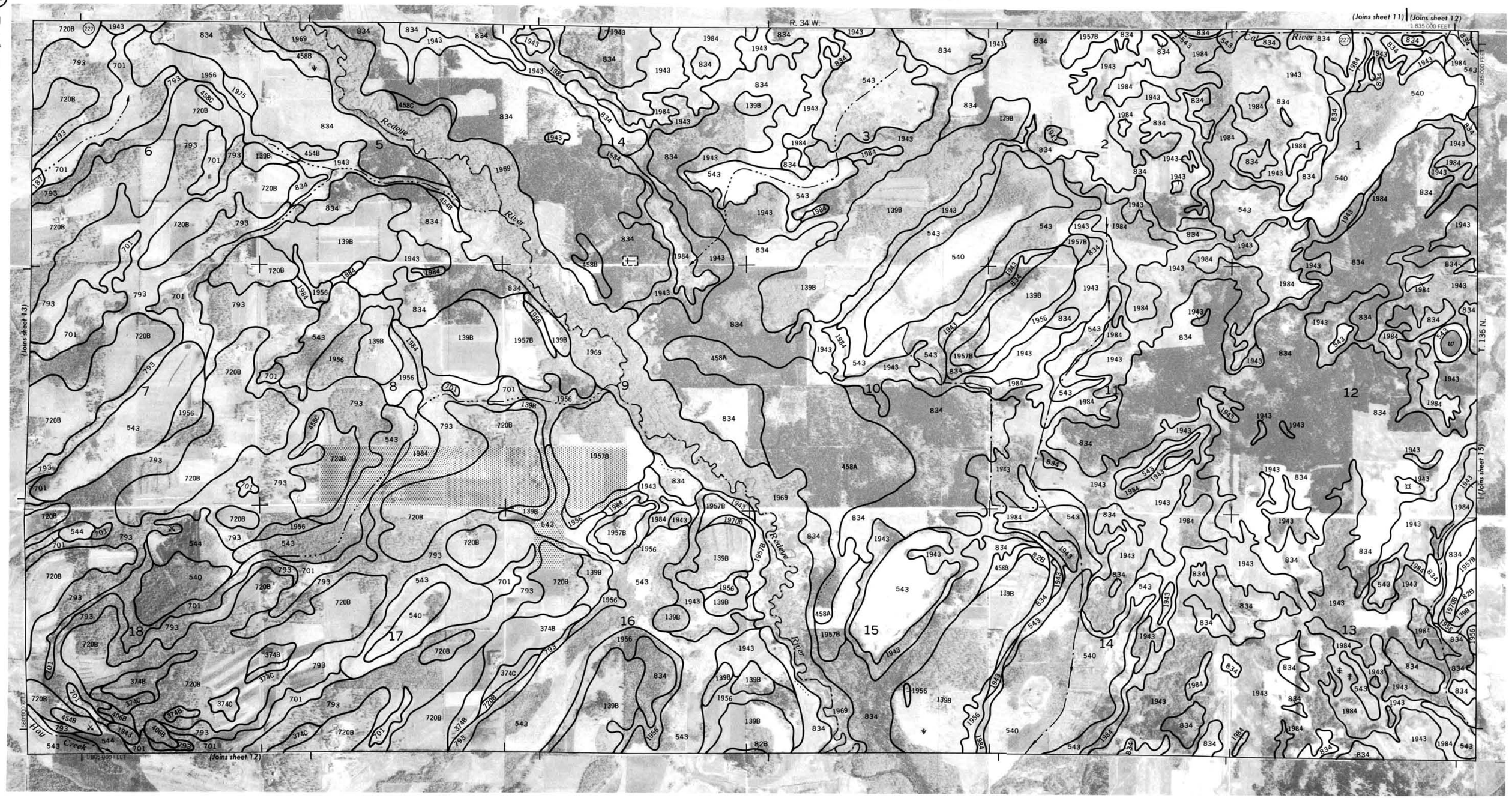
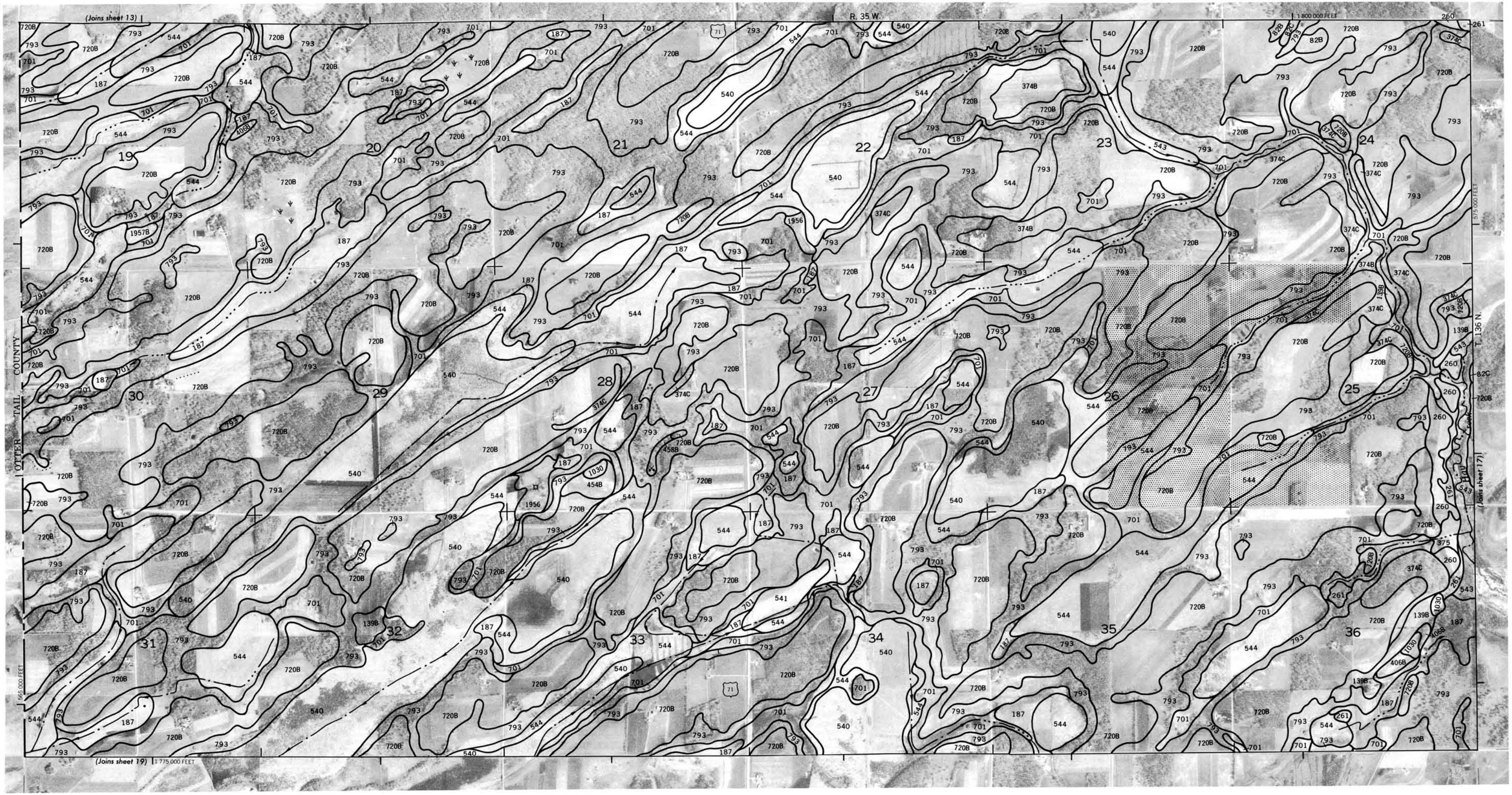


SOIL MAP OF WADENA COUNTY, MINNESOTA – SHEET NUMBER 15

SOIL MAP OF WADENA COUNTY, MINNESOTA – SHEET NUMBER 16



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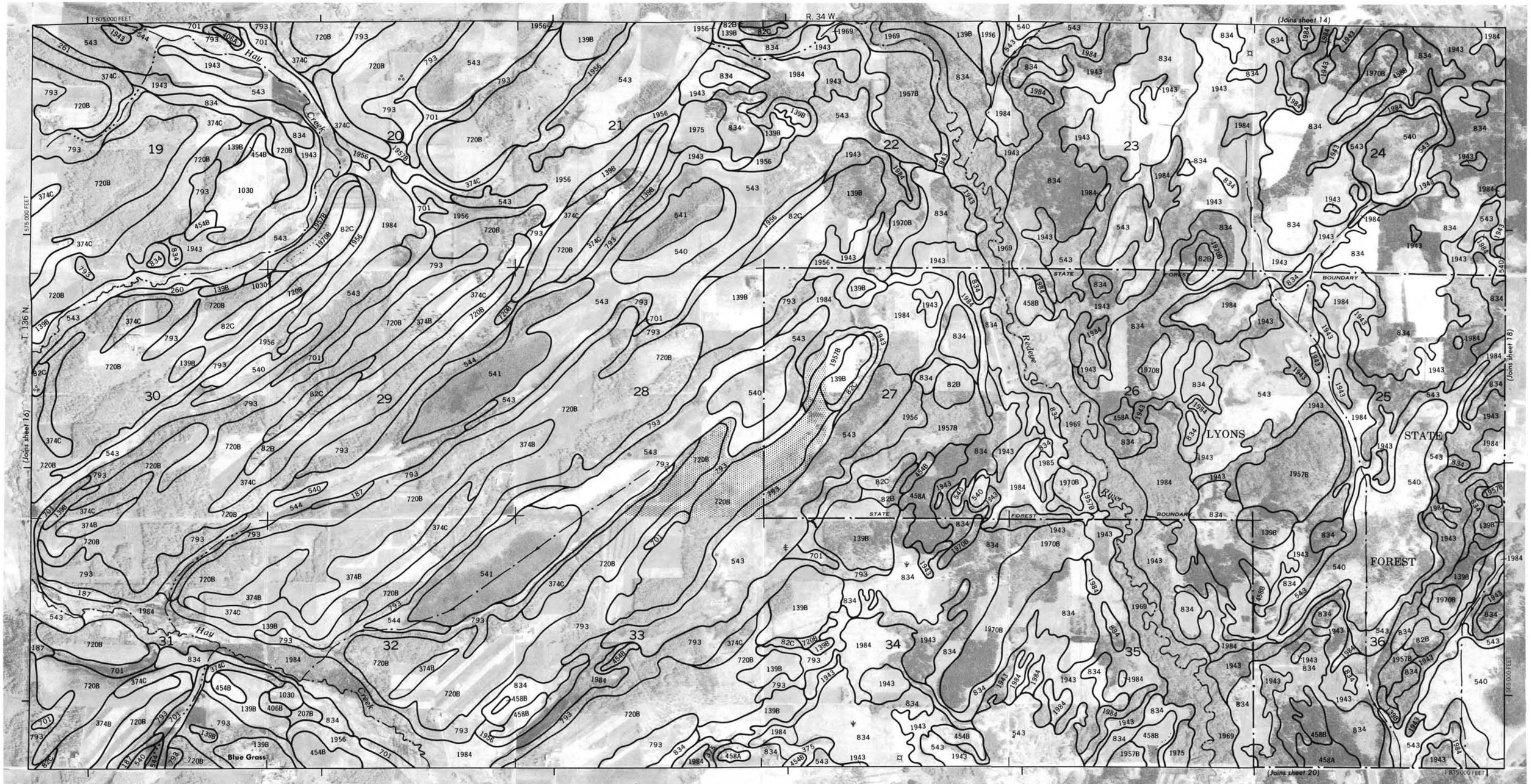

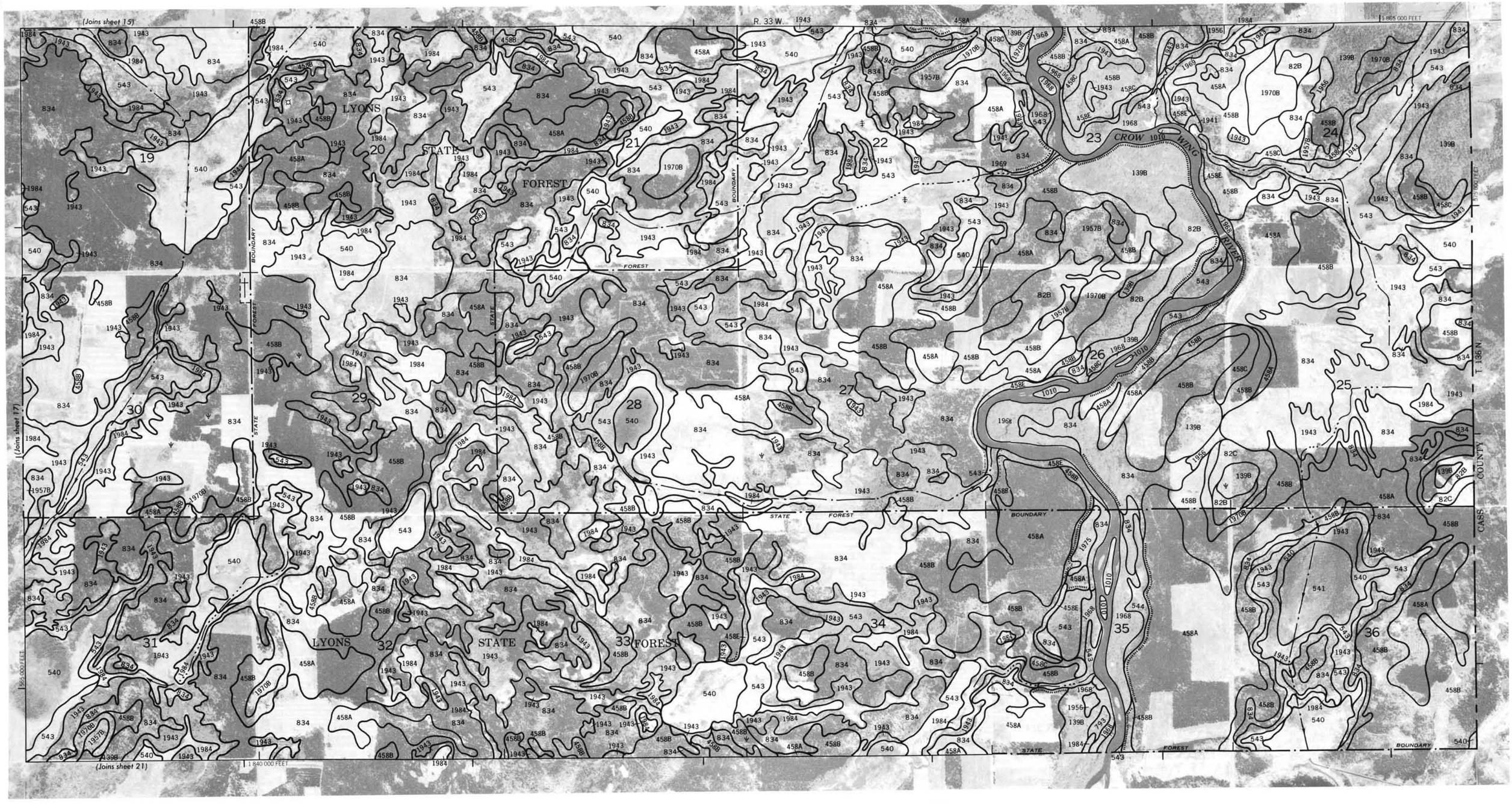
18
N
(Joins sheet 15)
R. 33 W.
1 865 000 FEET
LYONS
STATE
FOREST
CROW WING RIVER
CASS COUNTY
T. 136 N.
(Joins sheet 17)
(Joins sheet 21)
1 840 000 FEET
BOUNDARY
19
20
21
22
23
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32
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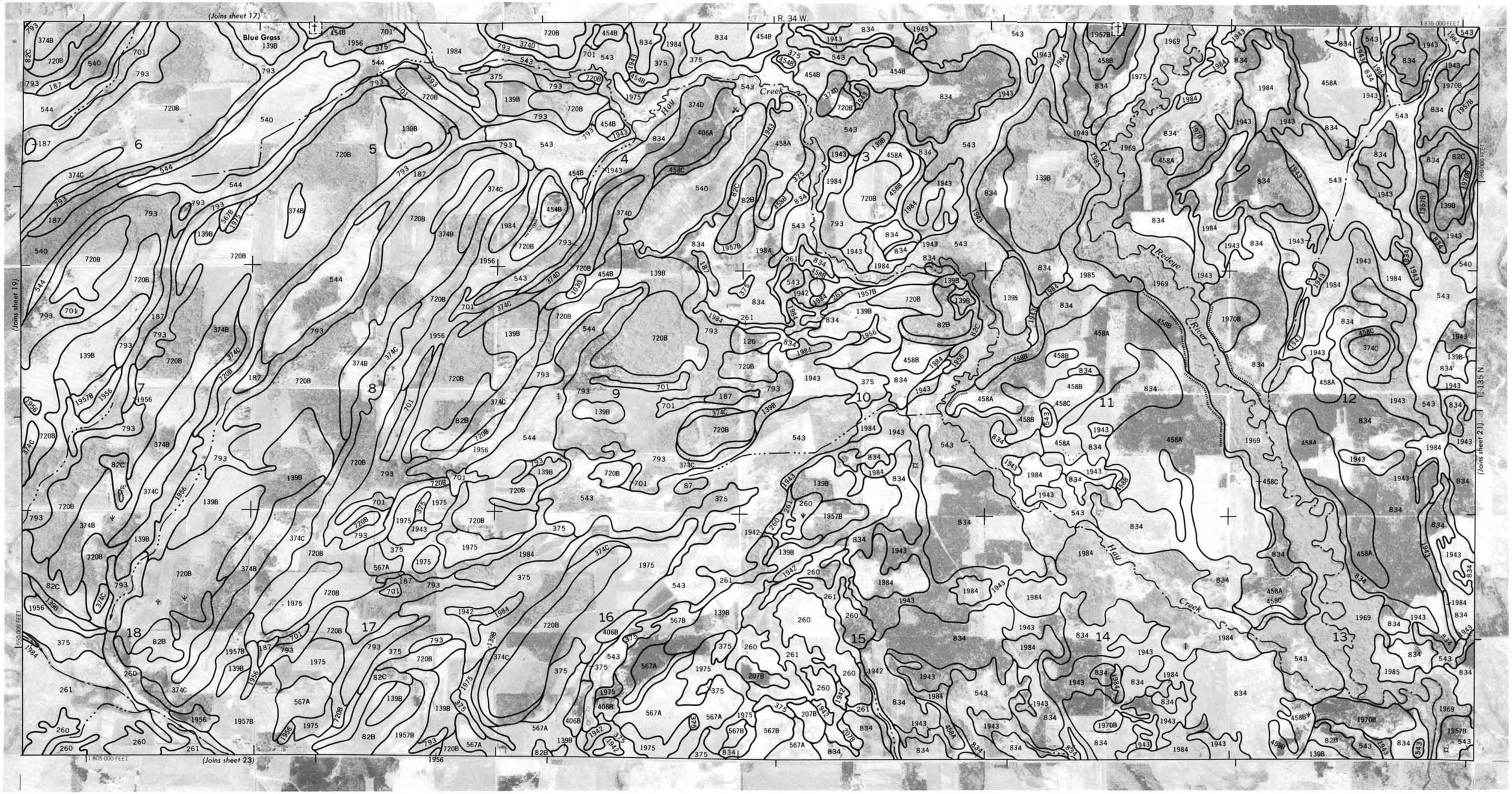
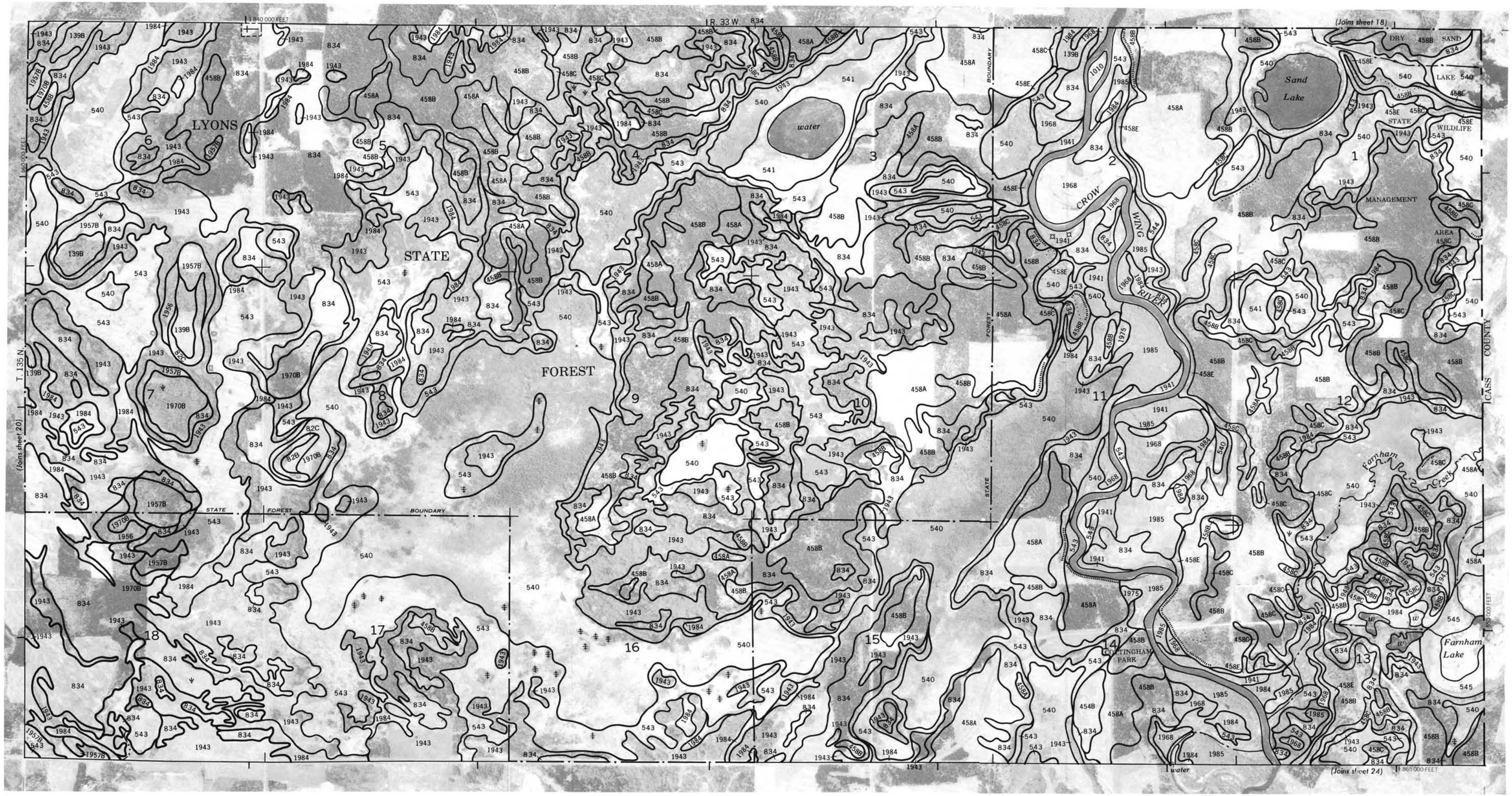
36

SOIL MAP OF WADENA COUNTY, MINNESOTA – SHEET NUMBER 19


N
(Joins sheet 17)
R. 34 W.
1 835 000 FEET
540 000 FEET
T. 135 N.
(Joins sheet 19)
(Joins sheet 21)
(Joins sheet 23)
1 805 000 FEET
550 000 FEET
Blue Grass
Creek
S. Hay
Redeye
River
Hay
Creek

SOIL MAP OF WADENA COUNTY, MINNESOTA – SHEET NUMBER 21



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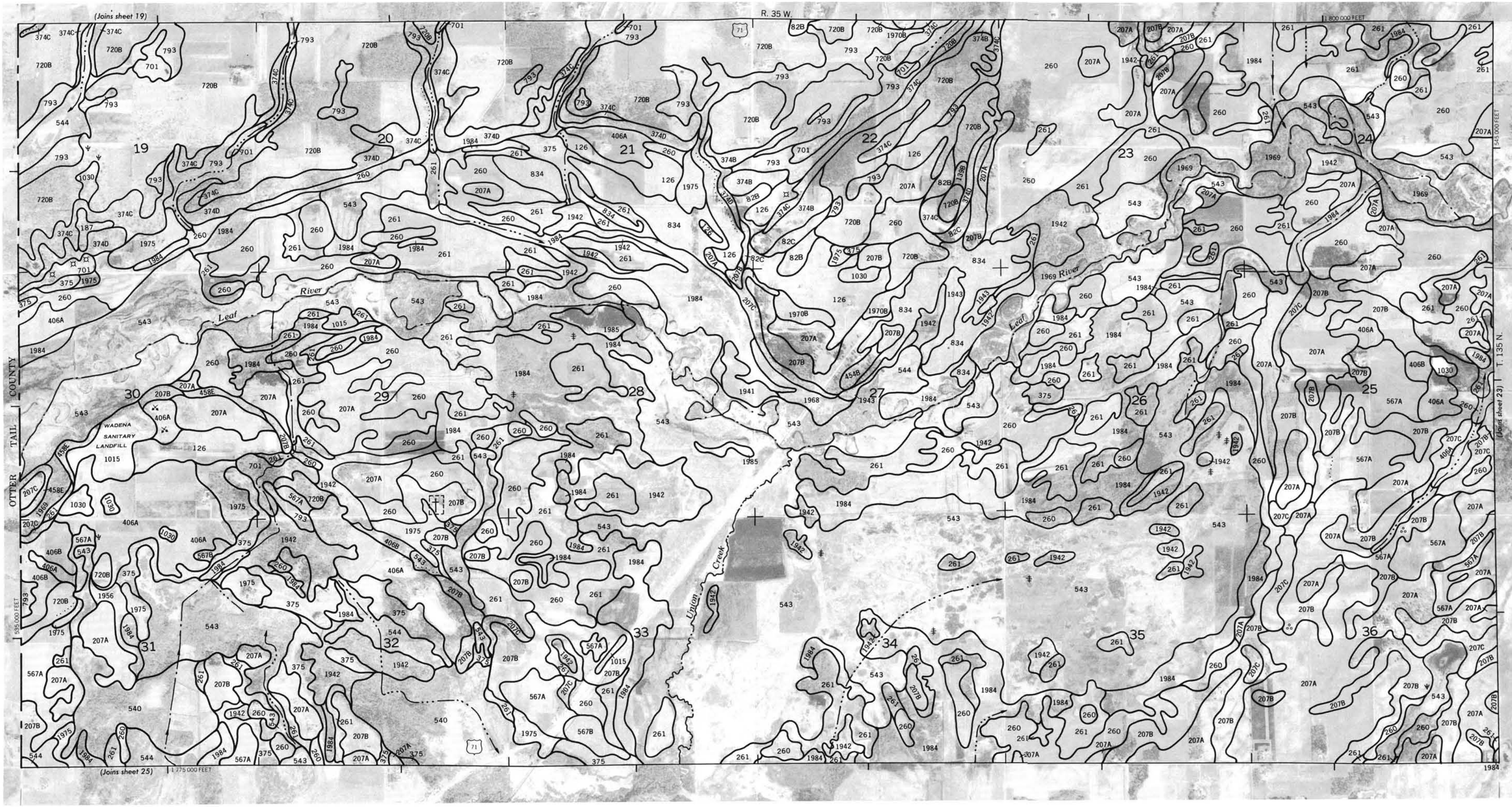
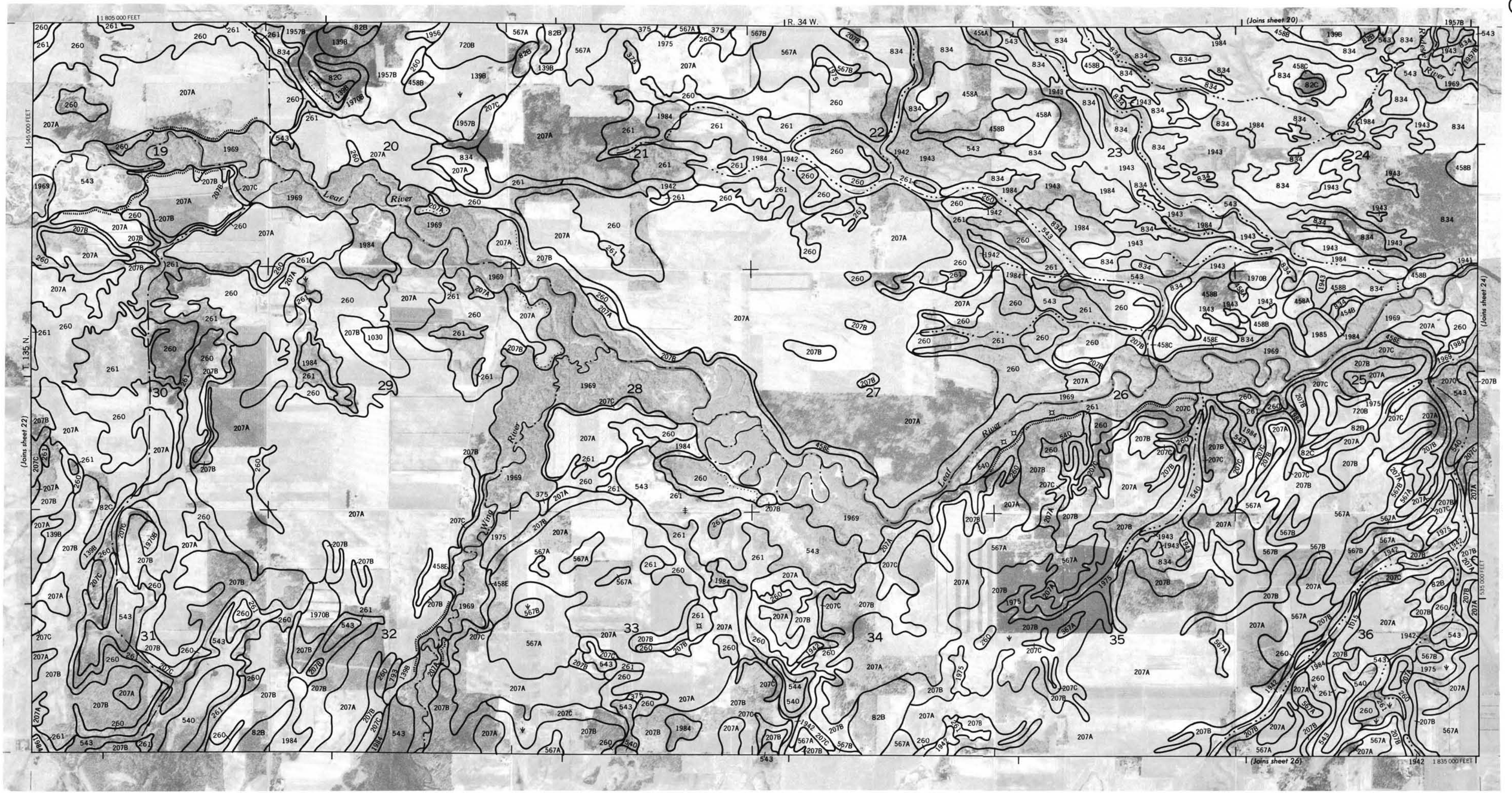


SOIL MAP OF WADENA COUNTY, MINNESOTA – SHEET NUMBER 23



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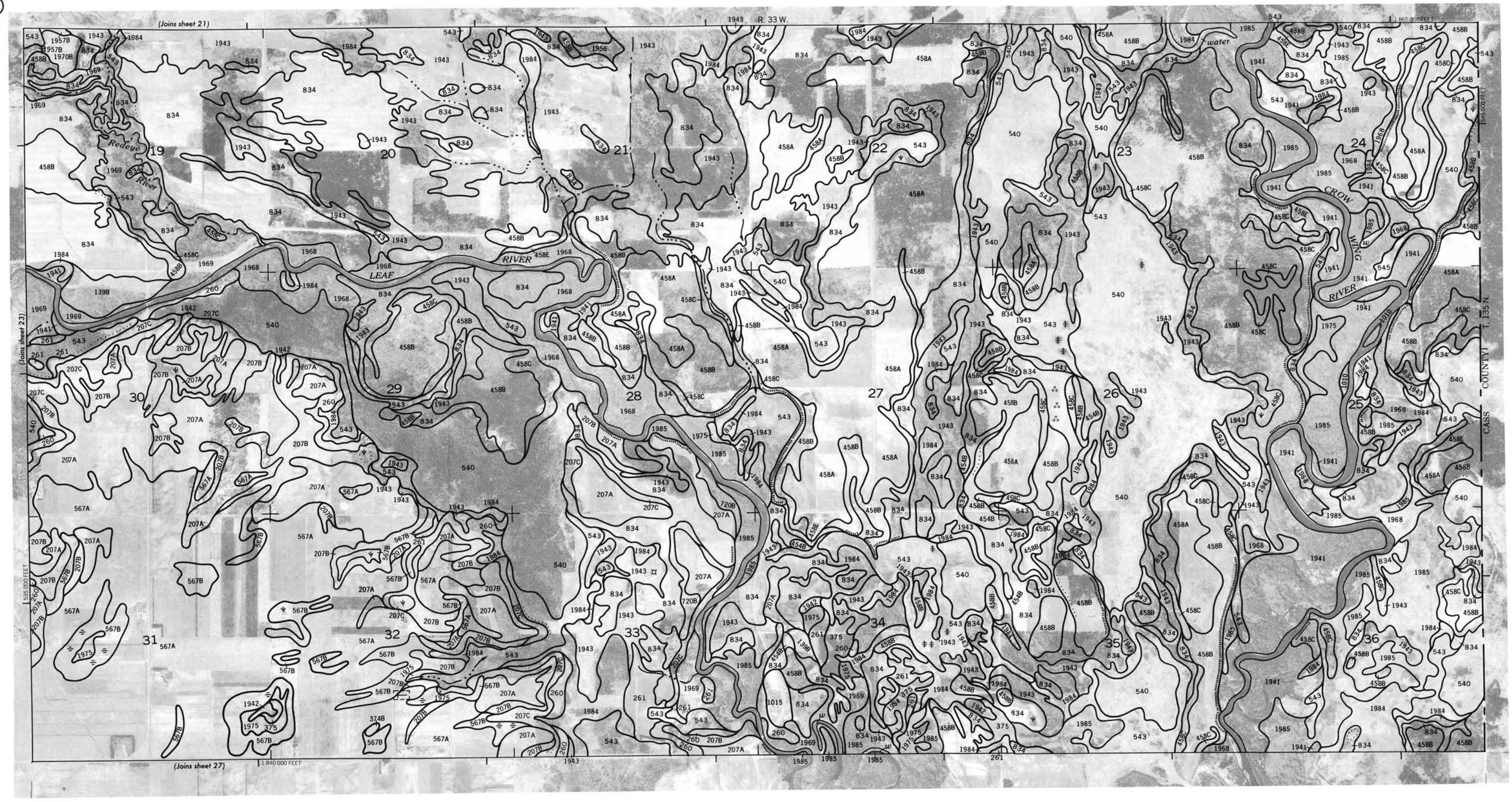

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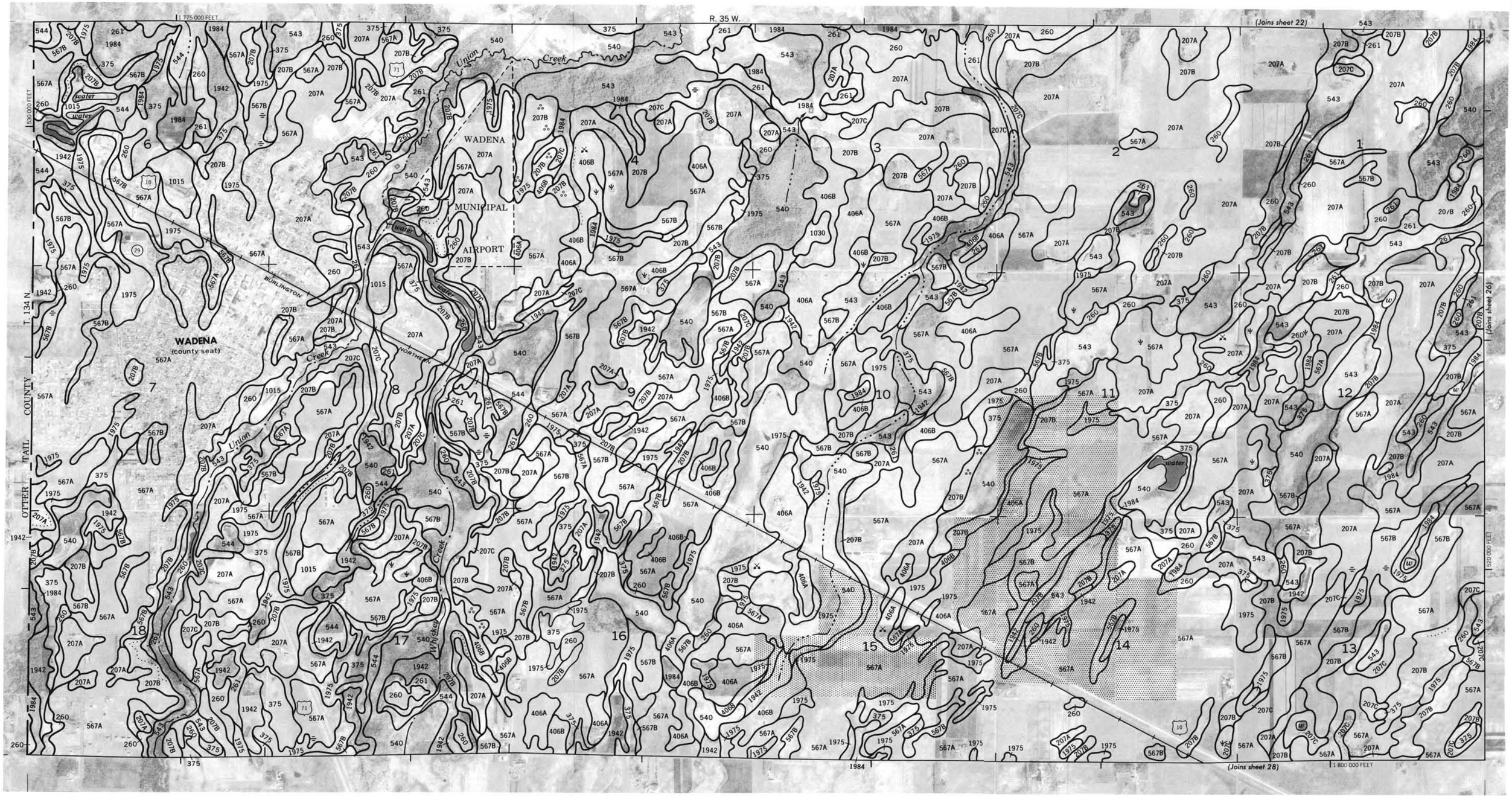

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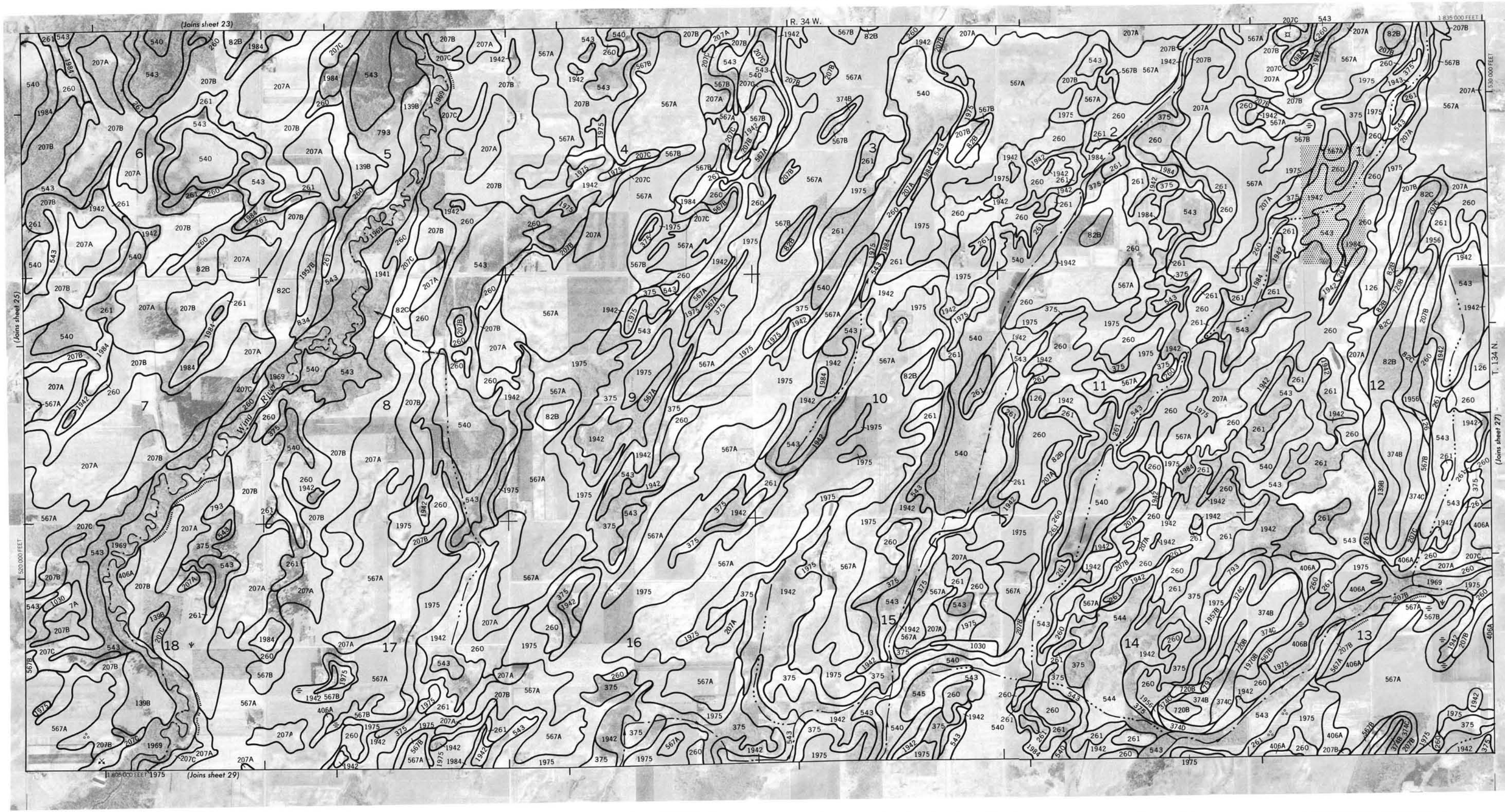

SOIL MAP OF WADENA COUNTY, MINNESOTA — SHEET NUMBER 27


28
N
(Joins sheet 25)
R. 35 W.
T. 134 N.
(Joins sheet 29)
OTTER TAIL COUNTY
TODD COUNTY
Union Creek
Whiskey Creek
Crow Wing River
BURLINGTON NORTHERN
1 800 000 FEET
515 000 FEET
505 000 FEET
1 575 000 FEET
19
20
21
22
23
24
25
26
27
28
29
30
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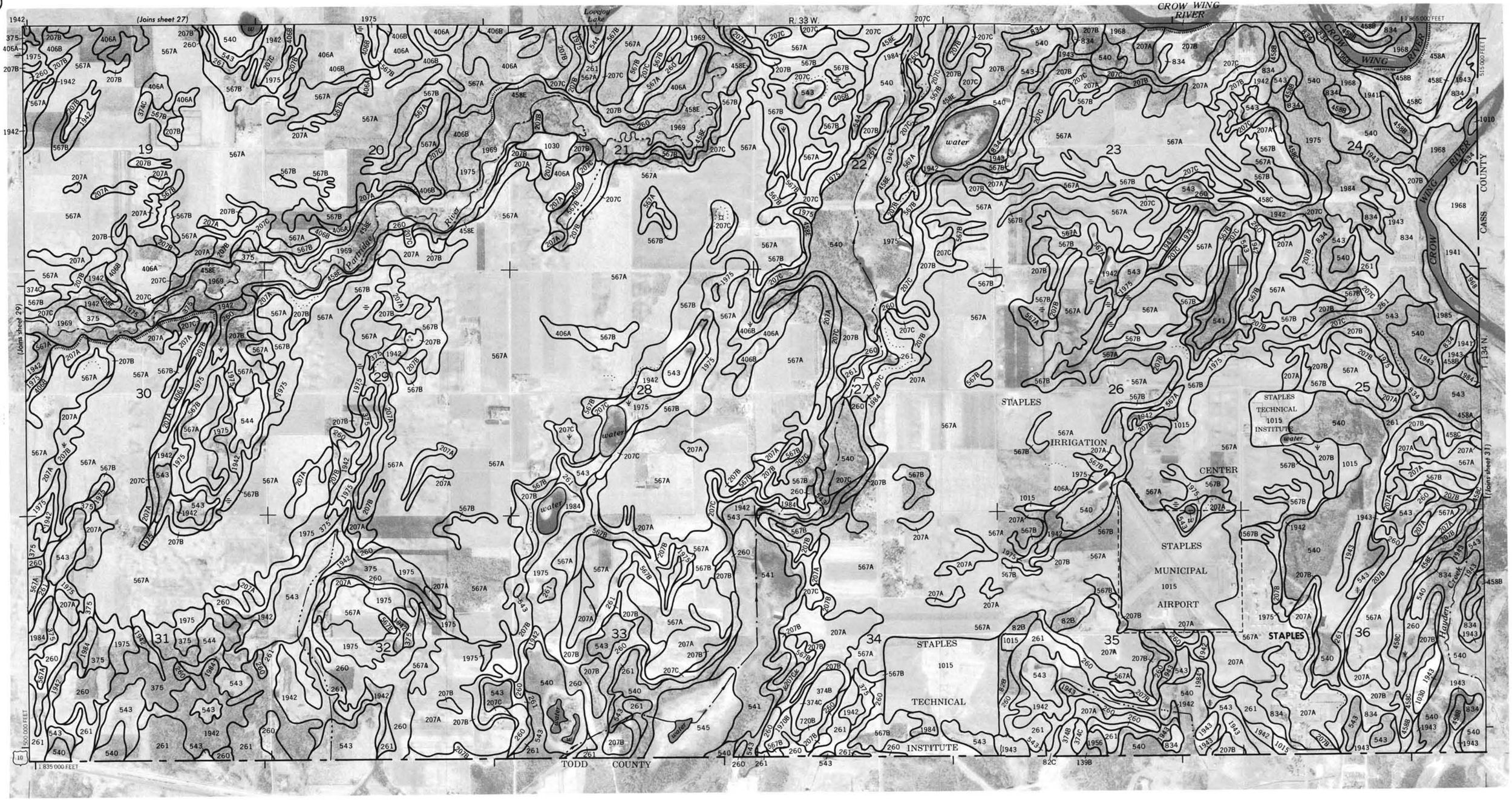
SOIL MAP OF WADENA COUNTY, MINNESOTA – SHEET NUMBER 29

SOIL MAP OF WADENA COUNTY, MINNESOTA - SHEET NUMBER 30



SOIL MAP OF WADENA COUNTY, MINNESOTA – SHEET NUMBER 31